



LAC-IEE-15-05

ENVIRONMENTAL THRESHOLD DECISION

Activity Location:	Latin America and the Caribbean
Activity Title:	Programmatic Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) for Coffee, with Emphasis on Coffee Rust
Activity Number:	N/A
Life of Activity Funding:	N/A
Life-of-Activity:	FY 2015 - FY 2020
IEE/PERSUAP prepared by:	GEMS II, The Cadmus Group, Inc.
Referenced ETDs:	N/A
Recommended Threshold Decision:	Negative Determination with Conditions
Bureau Threshold Decision:	Negative Determination with Conditions
Comments:	

This Environmental Threshold Decision approves the attached Programmatic PERSUAP for Coffee in the Latin America and Caribbean region. It is intended to be used for regional activities supporting the control of coffee rust, as well as for bilateral or mission funded activities that support coffee production. Any existing activities supporting coffee production are hereby authorized to use this PERSUAP in place of their existing PERSUAPs (e.g. Haiti, LAC-IEE-11-29, Guatemala LAC-IEE-12-41). Any necessary modifications to this PERSUAP for its application to existing activities will be made through an IEE amendment. All new coffee production activities in the LAC region will adhere to this Programmatic PERSUAP, and make any necessary modifications related to any host country regulations through the IEE for the new activity.

A **Negative Determination with Conditions** is issued to all USAID activities in the LAC region for the use of pesticides in relation to coffee production in accordance with 22 CFR 216.3(b)(1)(i) through (v). Conditions include:

1. The PERSUAP documents potential impacts and necessary mitigation measures or recommendations; therefore the preparation of a complete Environmental Mitigation Plan and Report (EMPR) is not required. However, the Implementing Partner will list the recommendations/mitigation measures of the PERSUAP in Table 3 of the EMPR form and complete the monitoring planning section of Table 3 (see attached). Table 3 will then be used by the Implementing Partners as the tool for monitoring the mitigation measures.
2. The Implementing Partners will ensure that all activities conducted under this instrument comply with this ETD. Also, through its regular reporting requirements, a section on environmental compliance will be included that uses the monitoring results that will be documented in Table 3 of the EMPR.
3. The COR/AORs of USAID-supported coffee production activities in LAC and corresponding MEOs will conduct spot check monitoring of the implementation and effectiveness for the mitigation measures listed in the Table 3 EMPR form.
4. An amendment to this Programmatic PERSUAP, and ETD, will be made on an annual basis.

Responsibilities

- Each activity manager or **Contracting (or Agreement) Officer Representative (COR/AOR)** is responsible for making sure environmental conditions are met (ADS 204.3.4). In addition, COR/AORs are responsible for ensuring that appropriate environmental guidelines are followed, mitigation measures in the IEE are funded and implemented, and that adequate monitoring and evaluation protocols are in place to ensure implementation of mitigation measures.
- It is the responsibility of the **Development Objective (SO) Team** to ensure that environmental compliance language from the ETD is added to procurement and obligating documents, such as activity-related Development Objective Grant Agreements (DOAGs), program descriptions, and statements of work.
- The **Mission Environmental Officer** will conduct spot checks to ensure that conditions in the IEE and this ETD are met. These evaluations will review whether guidelines are properly used to implement activities under this ETD in an environmentally sound and sustainable manner according to USAID and applicable U.S. Government policies and regulations.
- The implementing **contractor or partner** will ensure that all activities conducted under this instrument comply with this ETD. Also, through its regular reporting

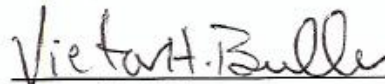
requirements, a section on environmental compliance (e.g. mitigation monitoring results) will be included.

Amendments

- Amendments to Initial Environmental Examinations (IEE) shall be submitted for LAC Bureau Environmental Officer (BEO) approval for any activities not specifically covered in the IEE, which include:
 - Funding level increase beyond ETD amount,
 - Time period extension beyond ETD dates (even for no cost extension), or
 - A change in the scope of work, such as the use of pesticides or activities subject to Foreign Assistance Act sections 118 and 119 (e.g. procurement of logging equipment), among others.
- Amendments to IEEs include Environmental Assessments (EA or PEA) and approval of these documents by the LAC BEO could require an annual evaluation for environmental compliance.

 Date 1/7/15

Dennis Durbin
Bureau Environmental Officer
Bureau for Food Security

 Date Jan 5, 2015

Victor H. Bullen
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IEE File

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Coffee Programmatic PERSUAP)

**PROGRAMMATIC PESTICIDE EVALUATION REPORT AND SAFE USE ACTION
PLAN (PERSUAP) FOR COFFEE, WITH EMPHASIS ON COFFEE RUST**

For:

**USAID Latin America and Caribbean (LAC) Bureau
and
USAID Bureau for Food Security (BFS)**

Dates of Study:

Background Desk Work: 14 Nov 2013 – 15 Jan 2014
Field Work in Nicaragua, Colombia & Dominican Republic: 14 Feb 2014 – 17 May 2014

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ACRONYMS

AI	Active Ingredient (reference to chemical/s in pesticides)
A/COR	Agreement/Contracting Officer's Representative (USAID)
APS	American Phytopathological Society
BEO	Bureau Environmental Officer (USAID)
BFS	Bureau for Food Security (USAID)
CFR	Code of Federal Regulations (USA)
CMP	Crop Management Plan
COP	Chief of Party (USAID)
E	Emulsion (a pesticide formulation)
EA	Environmental Assessment
EC	Emulsifiable Concentrate (pesticide formulation)
EC50	Effective Concentration 50 (acute toxicity measure)
EMMP	Environmental Mitigation and Monitoring Plan (USAID)
EPA	US Environmental Protection Agency (also known as USEPA)
ETOA	Environmental Threats and Opportunities Assessment (FAA 118/119)
EU	European Union
FAA	Foreign Assistance Act
FAO	Food and Agriculture Organization (United Nations)
FDA	Food and Drug Administration (USA)
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act (USA)
FRAC	Fungicide Resistance Action Committee
GAP	Good Agriculture Practice
GlobalGAP	Global Good Agriculture Practices, a certification system
GMO	Genetically Modified Organism
GUP	General Use Pesticide
Ha	Hectares
HRAC	Herbicide Resistance Action Committee
HT	Highly Toxic
ID	Identification
IEE	Initial Environmental Examination (USAID)
IP	Implementing Partner
IPM	Integrated Pest Management
IRAC	Insecticide Resistance Action Committee
LAC	Latin America and Caribbean (Bureau of USAID)
LC50	Lethal Concentration 50 (acute toxicity measure)
LD50	Lethal Dose 50 (acute toxicity measure)
LLC	Limited Liability Corporation
M&E	Monitoring and Evaluation
MEO	Mission Environmental Officer (USAID)
MOA	Ministry of Agriculture
MOE	Ministry of Environment
MRL	Maximum/Minimum Residue Level/Limit
MSDS	Material Safety Data Sheet
MSL	Meters above Sea Level
MT	Moderately Toxic
NAT	Not Acutely Toxic
NCAT	National Center for Appropriate Technology (USA)
NEPA	National Environmental Policy Act (USA)
NGO	Non-Governmental Organization

NIFA	National Institute of Food and Agriculture (USA)
OD	Oil Dispersion (a pesticide formulation)
PAN	Pesticide Action Network (pesticide NGO)
PEA	Programmatic Environmental Assessment (USAID)
PER	Pesticide Evaluation Report
PERSUAP	Pesticide Evaluation Report and Safe Use Action Plan
pH	log of Hydrogen concentration, measure of acidity
PHI	Pre-Harvest Interval
PIC	Prior Informed Consent (a treaty, relates to toxic pesticides)
POPs	Persistent Organic Pollutants (a treaty, relates to toxic persistent pesticides)
PMP	Pest Management Plan
PNT	Practically Non-Toxic
PPE	Personal Protection Equipment
QC	Quality Control
R&D toxin	Reproductive and Developmental toxin
REA	Regional Environmental Advisor
Reg 216	Regulation 216 (USAID Environmental Procedures under 22 CFR 216.3 (b))
REI	Re-Entry Interval (safety period after pesticide spraying)
RUP	Restricted Use Pesticide
SC	Suspension Concentrate (a pesticide formulation)
SL	Soluble Liquid (a pesticide formulation)
S&C	Standards and Certification
SOW	Scope of Work
SPU	Safe Pesticide Use
ST	Slightly Toxic
SUAP	Safe Use Action Plan
UC Davis	University of California at Davis
UM	University of Michigan
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNEP	UN Environment Program
UNFAO	UN Food and Agriculture Organization (also known as FAO)
US	United States
USAID	US Agency for International Development
USD	US Dollars
USDA	US Department of Agriculture
USEPA	US Environmental Protection Agency (also known as EPA)
VHT	Very Highly Toxic
WCR	World Coffee Research (at Texas A&M)
WG	Water Dispersible Granule (a pesticide formulation)
WHO	World Health Organization (United Nations)
WP	Wettable Powder (a pesticide formulation, usually for fungicides)
WPS	Worker Protection Safety (EPA program)

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ACKNOWLEDGMENTS

The PERSUAP team of Guatemalan Field Agriculture and Coffee Expert Manfredo Lopez Pineda, American International Environmental Assessment Professional Alan Schroeder, and Dominican Agriculture Sector Development Expert Jeannette Dominguez gratefully acknowledges The Cadmus Group, Inc., especially Jim Jolley and Mark Stoughton for contracting and facilitating this study, and Ashley Fox for managing invoices and payments.

USAID, USDA (US Department of Agriculture) and US Embassy staff members in each country visited are also acknowledged for organizing and spending valuable time with the team. In Nicaragua, this includes MEO Mappy Cortez, USDA Jimmy Bolanos, Angela Contreras and Lillian Baez. In Colombia this includes MEO Daniel Lopez and Agriculture Officer Christopher Abrams. And, in Dominican Republic, this includes Environmental Officers Monica Bansal and Odalis Perez, as well as Deputy Mission Director Jim Wright. Their local expertise and foresight helped make each coffee field mission a success.

The list of government, multilateral, private sector specialty coffee exporters, NGO experts, pesticide sector experts and farmers is too long to list here; but without their support providing expert information and opinions, this study would not have been possible. Additional USAID experts in each focus country and Washington who will review this document are also gratefully acknowledged for their expertise and patience with this process.

**PROGRAMMATIC PERSUAP FOR COFFEE, WITH EMPHASIS ON COFFEE RUST,
APPROVALS**

Approval: _____ Date: _____
 USAID/Acting BFS BEO Dennis Durbin

Approval: _____ Date: _____
 USAID/LAC BEO Victor Bullen

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 A/CORs covering coffee programs/projects

EXECUTIVE SUMMARY

Background

Coffee production, processing and marketing is an important part of USAID’s strategy for sustainable development in the Latin America and the Caribbean (LAC) – at least ten USAID countries currently support coffee activities in the region. Early in 2013 USAID began hearing of severe outbreaks of coffee rust, a fungal disease affecting coffee farms, in Central America, Peru, the Dominican Republic and other countries in LAC. Soon after, epidemic levels were confirmed and several countries declared states of emergency due to the anticipated agricultural and economic impact of the disease. Coffee rust will have significant adverse effects on smallholder livelihoods, rural economies more broadly, national balance-of-payments, and the success of alternative livelihoods programs. Multiple USAID missions and programs in LAC and the USAID Bureau of Food Security (BFS) programs are of necessity engaged in coffee rust response.

Pesticide Evaluation Report and Safe Use Action Plans (PERSUAPs) for LAC and BFS coffee production activities recommend a variety of approaches to prevention and control of coffee rust, herein referred to as “rust”. Some PERSUAPs do not list coffee rust as an important disease, while others provide detailed Integrated Pest Management (IPM) plans and treatment schedules for coffee rust control. These approaches do not consistently capture current good practice. Consistent extension services and technical assistance to control the disease, embodying best IPM practices based on up-to-date research and experience, will be key elements of USAID’s response to the coffee rust epidemic.

The Programmatic PERSUAP for Coffee, with Emphasis on Coffee Rust, addresses this issue of consistency by compiling and analyzing—across LAC countries—all good agricultural practices (GAPs) useful for renovating coffee farms and strengthening coffee plants, which helps to prevent rust. Additionally, this study analyzes all fungicides that are generally used to prevent or control rust, across the region, and herbicides used for weed control. The PERSUAP also touches on the perceived impact of climatic changes on coffee and rust, and how it might be possible that adding shade may reduce some of those impacts and may result in a more sustainable cultivation system given global climate change.

Methodology

This programmatic PERSUAP has been developed based on desk top research and remote consultation with coffee industry stakeholders and experts in the LAC region and on field work to consult with local experts and stakeholders in Nicaragua (April 2014), Columbia (May 2014) and the Dominican Republic (May 2014). In each country visited, the team interviewed USAID staff, the national coffee promotion organizations, officials from the Ministries of Agriculture (MOA), specialty coffee exporters, coffee researchers, local agriculture input shops, as well as farmers with coffee fields of various size and scale of complexity. Additional consultation and research in Guatemala was conducted separately by team members residing there. Research included a thorough review of the LAC PERSUAPs developed over the last five years in coffee producing countries and a survey based on a questionnaire submitted to coffee experts in LAC countries, regional stakeholders, and research institutions.

Purpose

In compliance with USAID's Pesticide Procedures (22 CFR 216.3(b)), this Programmatic PERSUAP for Coffee, with Emphasis on Coffee Rust, for the USAID LAC Bureau and USAID BFS:

- **Establishes the set of pesticides for which support is authorized** on USAID coffee production activities. *Support includes purchase, direct use, recommending for use, financing, and other actions that directly facilitate the use of pesticides.*
- **Establishes requirements attendant to support for these pesticides** to assure that pesticide use or support (1) embodies the principles of safer pesticide use and, (2) per USAID policy, is within an integrated pest management (IPM) framework.

These requirements come into effect upon approval of the PERSUAP.

Following approval of the Programmatic PERSUAP for Coffee, with Emphasis on Coffee Rust, missions will amend their Initial Environmental Examinations (IEEs) so that coffee rust response is subject to a negative determination with conditions, the condition being compliance with the regional SUAP, including the recommended chemical controls and IPM practices. Any regional or Washington-initiated activities could also incorporate this PERSUAP as part of their IEEs.

Scope

LAC and BFS programs, projects, and activities of implementing partners (IPs), and the IP's sub-grantees, partners, financiers and beneficiaries are covered by this PERSUAP.

The set of authorized pesticides and requirements for safer use are established through Section 3, the Pesticide Evaluation Report (PER), which assesses the 12 pesticide risk evaluation factors (identified as A through L) required by 22 CFR 216.3(b). Pesticides that clear this 12-factor analysis can be promoted to beneficiaries, financed and used on demonstration farms.

The Safer Use Action Plan (SUAP) in Section 4 provides a succinct, stand-alone statement of compliance requirements, synthesized from the 12-factor analysis. The SUAP also provides an Environmental Mitigation and Monitoring Plan (EMMP) for assigning responsibilities and timelines for implementation of these requirements. **Each project subject to this PERSUAP must complete and submit this SUAP EMMP to its AOR/COR.**

Parameters for this PERSUAP

Regulation 216, in the absence of a full Environmental Assessment (EA), stipulates that pesticides not registered by the U.S. Environmental Protection Agency (EPA) for the same or similar uses in the USA, or those pesticide *products* that are labeled as Restricted Use Pesticides (RUPs) cannot be used on USAID projects. This PERSUAP also rejects for use with USAID resources Class I pesticides (with the exception of copper-containing chemicals and rodenticides), known carcinogens and known water pollutants.

It was agreed at the outset of this study to focus most of the analyses on the objective common denominator of pesticide Active Ingredient (AI), instead of pesticide commercial product names.

Pesticide “use” was agreed, in consultation with USAID to include promotion to beneficiaries via training or extension, financing, or use on demonstration activities.

Pesticide Definition

For the purposes of this PERSUAP, the word *pesticide* is used, following EPA’s guidelines¹, for the following: fumigants, insecticides, miticides/acaricides, nematocides, molluscicides, fungicides, antimicrobials, bactericides/biocides, microbicides/antibiotics, herbicides, rodenticides, avicides, algicides, ovicides, disinfectants/sanitizers and anti-fouling agents (chemicals that repel or kill things like barnacles that attach to boats). Even biological agents such as biopesticides, microbial pesticides, attractants/pheromones, repellents, defoliants, desiccants and insect growth regulators are included as pesticides.

Findings: Allowed Pesticides for Primary Coffee Pests, Diseases and Weeds

USAID requires the use of preventive IPM tools and tactics for each crop-pest combination (as described in the IPM matrix in Annex 1) before the choice is made to purchase and use synthetic pesticides. In the context of a strong IPM program, the following pesticides have been analyzed, and are allowed, if necessary, to control common coffee pests, diseases and weeds. (Note that these pesticides are repeated by function, e.g. insecticide or nematocide, in Section 3.1, “Factor A: EPA Registration Status of the Proposed Pesticide.”)

Coffee Pest or Disease	Allowed Pesticides
Coffee leaf rust (CLR, la roya) <ul style="list-style-type: none"> <i>Hemileia vastatrix</i> 	<ul style="list-style-type: none"> Bordeaux mixture captan copper hydroxide copper oxychloride cuprous oxide tribasic copper sulfate ferbam mancozeb maneb ziram azoxystrobin cyproconazole flutriafol fosetyl aluminum myclobutanil oxycarboxyn propiconazole pyraclostrobin tebuconazole triadimefon

¹ <http://www.epa.gov/pesticides/about/types.htm>

Coffee Pest or Disease	Allowed Pesticides
	<ul style="list-style-type: none"> • triadimenol • trifloxystrobin
Coffee berry borer (CBB, la broca) <ul style="list-style-type: none"> • <i>Hypothenemus hampei</i>, Also named: • <i>Hypothenemus coffeae</i>, • <i>Xyleborus coffeivorus</i>, and • <i>Xyleborus coffeicola</i> 	<ul style="list-style-type: none"> • <i>Beauveria bassiana</i>
Coffee leaf miners (CLM) <ul style="list-style-type: none"> • <i>Leucoptera meyricki</i>, • <i>Perileucoptera coffeella</i> and • <i>Leucoptera coffeina</i> 	<ul style="list-style-type: none"> • cyromazine
Coffee Stem Boring Beetles (SBB) <ul style="list-style-type: none"> • Black borer (<i>Apate monachus</i>) • Twig borer (<i>Xylosandrus compactus</i>) • White Stem Borer (<i>Monochamus leuconotus</i>) 	<ul style="list-style-type: none"> • No effective chemical controls are known.
Coffee leaf and stem aphids CLA <ul style="list-style-type: none"> • Black citrus aphid (<i>Toxoptera aurantii</i>) and others 	<ul style="list-style-type: none"> • insecticidal soaps • neem oil • mineral oil • chili pepper extract • imidacloprid • thiamethoxam
Coffee mealy bugs (CMB) <ul style="list-style-type: none"> • Citrus mealy bug (<i>Planococcus citri</i>) • Coffee mealy bug (<i>Planococcus lilacinus</i>) • Passionvine mealy bug (<i>Planococcus minor</i>) • Striped mealy bug (<i>Ferrisia virgata</i>) 	<ul style="list-style-type: none"> • insecticidal soaps • malathion • imidacloprid • thiamethoxam
Coffee scales (CS) <ul style="list-style-type: none"> • Soft green scale (<i>Coccus viridis</i>) 	<ul style="list-style-type: none"> • mineral oil • carbaryl

Coffee Pest or Disease	Allowed Pesticides
<ul style="list-style-type: none"> • Citrus mealybug (<i>Planococcus citri</i>) • Hemispherical scale (<i>Saissetia coffeae</i>) • White wax scale (<i>Ceroplastes destructor/brevicauda</i>) 	<ul style="list-style-type: none"> • dimethoate • malathion • thiamethoxam
<p>Coffee mites (CM)</p> <ul style="list-style-type: none"> • Coffee Red Mite (<i>Oligonychus coffeae</i>) • Southern Red Mite (<i>Oligonychus ilicis</i>) • Red Flat Mite (<i>Brevipalpus phoenicis</i>) 	<ul style="list-style-type: none"> • neem oil • mineral oil
<p>Root knot nematodes (RKN)</p> <ul style="list-style-type: none"> • <i>Meloidogyne</i> species 	<ul style="list-style-type: none"> • <i>Paecilomyces lilacinus</i> • <i>Bacillus firmus</i> • allyl isothiocyanate • capsaicinoids • <i>Myrothecium verrucaria</i> • extracts of tomatillo oil and thyme oil
<p>Coffee berry disease (CBD)</p> <ul style="list-style-type: none"> • <i>Colletotrichum kahawae/coffeeanum</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • Bordeaux mixture • Sodium bicarbonate • cuprous oxide • copper oxychloride • tribasic copper sulfate • <i>Pseudomonas fluorescens</i> • azoxystrobin • thiophanate-methyl • propiconazole • thiram • pyraclostrobin
<p>Coffee Anthracnosis (CA)</p> <ul style="list-style-type: none"> • <i>Colletotrichum gloeosporioides</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • Bordeaux mixture • Sodium bicarbonate • cuprous oxide • copper oxychloride

Coffee Pest or Disease	Allowed Pesticides
	<ul style="list-style-type: none"> tribasic copper sulfate azoxystrobin ferbam cyproconazol <i>Pseudomonas fluorescens</i>
Rooster's eye leaf spot (RES) <ul style="list-style-type: none"> <i>Mycena citricolor</i> 	<ul style="list-style-type: none"> neem seed oil mineral oil Bordeaux mix <i>Trichoderma harzianum</i> cyproconazole tebuconazole triadimenol thiabendazole
Cercospora brown leaf and fruit spot (CLS) <ul style="list-style-type: none"> <i>Cercospora/</i> <i>Mycosphaerlla coffeicola</i> 	<ul style="list-style-type: none"> neem seed oil mineral oil <i>Trichoderma harzianum</i> copper oxychloride copper oxide tribasic copper sulfate mancozeb triadimenol ferbam folpet
Coffee leaf Phoma black spot (CPS) <ul style="list-style-type: none"> <i>Phoma</i> species 	<ul style="list-style-type: none"> neem seed oil mineral oil <i>Trichoderma harzianum</i> copper oxychloride copper oxide tribasic copper sulfate mancozeb triadimenol ferbam
Coffee Collar Rot (CCR) <ul style="list-style-type: none"> <i>Phytophthora</i> species 	<ul style="list-style-type: none"> <i>Trichoderma harzianum</i> thiophanate-methyl
Coffee Limb Blight (CLB) <ul style="list-style-type: none"> <i>Corticium salmonicolor</i> 	<ul style="list-style-type: none"> Bordeaux mix copper oxychloride
Coffee black rot (CBR)	<ul style="list-style-type: none"> cyproconazole tebuconazole

Coffee Pest or Disease	Allowed Pesticides
<ul style="list-style-type: none"> • <i>Pellicularia koleroga</i> 	<ul style="list-style-type: none"> • triadimenol
Pseudomonas bacterial rot (PBR) <ul style="list-style-type: none"> • <i>Pseudomonas syringae</i> 	<ul style="list-style-type: none"> • Bordeaux mixture • cuprous oxide • copper oxychloride • tribasic copper sulfate • <i>Pseudomonas fluorescens</i>
Weeds Impacting Coffee (WIC) Various species	<ul style="list-style-type: none"> • 2,4-D • ametryne • clethodim • flazasulfuron • fluazifop-p-butyl • fomesafen-sodium • oryzalin • oxyfluorfen • pelargonic/nonanoic acid • sethoxydim • glyphosate

Findings: GAPs/IPM and Common Sense Actions

The following is a summary of the GAPs, IPM measures and common sense actions discovered during interviews with coffee sector experts, both in person in Nicaragua, Colombia and Dominican Republic as well as by phone and email, that promote strong, healthy stands of coffee that will be more able to tolerate or resist coffee rust. (These practices are described in more detail in Section 3.3 and should be implemented in consideration of IPM practices listed in Annex 1.)

- **Shade:** Add tall-tree shade (up to 50%);
- **Farm Renovation:** Cut off older plants or plant new vigorous seedlings;
- **Resistant Varieties:** Use varieties resistant to coffee rust;
- **Monitoring:** Consistently monitor plants for infection and infestation by diseases, insects or nematodes;
- **Replanting:** Replant bushes consistently hard-hit by insects or diseases;
- **Quality/Certified Seedlings:** Plant quality/certified disease-free seedlings;
- **Weed Control:** Remove weeds so that they do not take nutrients away from the coffee plant;
- **Pruning:** Prune to open the canopy for increased penetration of air, light, parasites and predators;
- **Fertilizer Use:** Conduct soil tests and use recommended fertilizers to make the plant stronger;

- **Topsoil Conservation:** Implement appropriate soil conservation measures for good soil and plant fertility;
- **Mixed Cropping:** Plant coffee with cash crops and fruit trees;
- **Intercropping:** Plant crops like legumes between rows of newly planted coffee seedlings;
- **Abandoned Farms:** Control abandoned farms that serve as a reservoir of pests and diseases that can spread;
- **Sanitation:** Remove dried up, infested and fallen berries and rust-infested leaves; and,
- **Other Coffee Pests:** Control other coffee pests and diseases that stress the plant and render its defenses weaker.
- **Cash Subsidies/Assistance:** Provide cash subsidies to qualified farmers who agree to maintain their coffee plants.
- **Certified Coffee Farms:** Promote market-driven voluntary standards and certification systems for coffee.

Results of Pesticide Evaluation Report (PER) 12-Factor Analyses

Below is a compilation of the results of the 12-factor analysis (Factors A-L) for the pesticides analyzed and justification for the pesticides that are eliminated. Those that are **accepted and recommended** are noted in the previous table. All the accepted and recommended pesticides are EPA registered and are not RUPs.

- **Factor A (EPA Registration and RUP Status) & Factor E (Acute and Long-Term Toxicological Hazards) Eliminated Pesticides:** Each of the pesticides eliminated based on Factor A and E pose toxicological hazards, as summarized in Annex 2, columns 5, 6 (acute human toxicity), 7 (chronic human toxicity), and 9-17 (ecotoxicity). The following pesticides were eliminated from the analysis for the reasons listed in the parentheses:
 - Protective contact fungicide AIs:
 - captafol (**not EPA registered**)
 - dithianon (**not EPA registered**)
 - fentin hydroxide (**RUP**)
 - zineb (**not EPA registered**)
 - Protective curative systemic fungicide AIs:
 - benomyl (**not EPA registered**)
 - carbendazim (**not EPA registered for agriculture**)
 - chlorothalonil (**Class I eye toxin**)
 - epoxiconazole (**not EPA registered**)
 - hexaconazole (**not EPA registered**)
 - pyracarbolid (**not EPA registered**)
 - Herbicides:
 - dalapon-sodium (**not EPA registered**)
 - diuron (**known carcinogen, known ground water pollutant**)
 - paraquat (**RUP, Class I**)
 - simazine (**known groundwater pollutant**)

- Fungicides for other diseases:
 - cypendazole (**not EPA registered**)
 - propineb (**not EPA registered**)
 - tridemorph (**not EPA registered**)
- Insecticide AIs:
 - aldicarb (**RUP**)
 - beta-cypermethrin (**RUP**)
 - bifenthrin (**RUP**)
 - carbofuran (**RUP**)
 - carbosulfan (**not EPA registered**)
 - chlorpyrifos (ethyl) (**not EPA registered for agriculture**)
 - deltamethrin (**a few formulations RUP for use on cotton**)
 - diazinon (**all horticulture uses RUP**)
 - endosulfan (**banned POP internationally**)
 - fenitrothion (**not EPA registered for agriculture**)
 - lambda-cyhalothrin (**RUP**)
 - methomyl (**RUP**)
 - oxamyl (**RUP**)
- Nematicide AIs:
 - 1, 3 dichloropropene (**RUP**)
 - aldicarb (**RUP**)
 - cadusafos (**not EPA registered**)
 - carbofuran (**RUP**)
 - carbosulfan (**not EPA registered**)
 - metam sodium (**RUP**)
 - oxamyl (**RUP**)
 - terbufos (**RUP**)
- **Factor B (Pesticide Selection Basis):** Generally, it is recommended that smallholder farmers select pesticides based upon advice from agrodealers and extension agents. Field visits and research found that farmers in LAC countries choose pesticides based primarily upon the price, efficacy and availability of products in quantities they desire and can afford. The field work confirmed that pesticide selection may also be based on the advice of agrodealers, extension agents and neighbors.
- **Factor C (IPM Program):** The IPM measures for each coffee pest, disease and weeds, including economic injury levels (EILs), are contained in Annex 1. Each of the extension services contacted during preparation of this PERSUAP promotes a coffee Pest Management Plan (PMP) with preventive GAP/IPM tools and tactics that should be integrated and used before pesticides are used. Most commercial plantation farms implement most of the best practices recommended. However, in most countries there are insufficient resources to reach many of the smallholder farms and farmers with this information.
- **Factor D (Pesticide Application and Safety Equipment):** Smallholder farmers use backpack sprayers to apply the pesticides considered in this PERSUAP. PPE availability/use depends on country, region (major coffee-producing region or small-scale production) and farm. PPE is recommended for all pesticide applicators.

- **Factor F (Pesticide Effectiveness)**: The majority of the pesticides sold in LAC countries are from major multinational as well as regional companies, which assures better quality control. Each of the chemicals evaluated during the Factor A analysis was researched for effectiveness. Each pesticide chosen for analysis was found, through conversations with farmers, extension officials, coffee technical organizations and coffee pest management websites, to be recommended as effective.
- **Factor G (Target and Non-Target Hazards)**: Annex 2 summarizes, in columns 9 through 17, the relative ecotoxicity (compatibility with nine types of non-target organisms) for each pesticide analyzed.
- **Factor H (Climate, Flora, Fauna, Geography, Hydrology, and Soils Pesticide Use Conditions)**: In general, Arabica coffee in LAC countries is grown in tropical highlands, where temperatures are moderately cool and ideal for coffee (15-24 degrees C). Rainfall averages 1500 to 2000 mm per year. Soils are predominantly sandy-loam. Most of these tropical highland soils provide good drainage; have a slightly acidic pH as well as a fairly balanced content of potassium, magnesium, calcium and phosphorus. The source of most tropical watersheds begins with streams and springs in the highlands; thus protection of these resources from overuse of fertilizers and pesticides is critical. The variety of conditions in each of the LAC countries cannot be described here. Please see the individual PERSUAPs for each country for further details.
- **Factor I (Availability of other pesticides or non-chemical control methods)**: Several LAC countries have laboratories to produce tiny wasps as well as *Beauveria bassiana* that help control coffee berry borer. Many fungi and bacteria have the potential to act as biological control agents against rust. Although there are possible natural controls including microbial rust antagonists in the research pipeline, none are available or commercially viable yet. Otherwise, there are numerous preventive non-chemical practices known to increase the strength or vigor of coffee plants thereby potentially reducing the severity of a rust infection.
- **Factor J (Host Country Pesticide Management Ability)**: The ability of LAC countries to regulate or control the distribution, storage, use and disposal of coffee pesticides depends upon staffing and resources for enforcement and extension. Often these are insufficient for the tasks at hand which is why donor projects fill in the gap, with technical and financial resources. Furthermore, market demand for “socially and environmentally responsible” coffee is driving the adoption of best practices on some larger commercial farms as well as on some boutique farms using best practices to capture certified markets. All coffee certification programs promote the use of sector best practices for the types, storage, use and disposal of coffee pesticides.
- **Factor K (Training)**: Each coffee producing country has national, private sector and donor programs for training and assisting smallholder farmers, but these programs do not have sufficient resources to reach all of them. This is where donors usually come in with additional resources. Many smallholder farmers know which pesticides to use for rust, but do not know how to properly calibrate sprayers and keep farm records. USAID projects are expected to use the GAP/IPM information in Annex 1 as well as pesticide safety websites referred to in this PERSUAP to train beneficiaries.

- **Factor L (Monitoring):** Most smallholder farmers do not keep farm records on pests prevented and controlled, chemicals and dosages used, and the effectiveness of each chemical application. If they complain that a certain chemical did not work properly, they may blame the product as being poor in quality, when in fact they may not have chosen the best chemical, miscalculated the correct dosage, misapplied the chemical, or not rotated among chemical classes often enough. USAID projects can assist with this need. USAID projects will keep records of crops supported, primary production constraints, as well as IPM, pesticides and personal protective equipment (PPE) used on supported farms.

Mandatory Safer Use Measures & Use Restrictions

Following from the PER analysis as summarized above, the mandatory safer use measures and restrictions attendant to the use of these pesticides are summarized as follows. (The PER and the annexes provide substantial resources to support compliance with these requirements.)

- Only pesticides approved by this PERSUAP may be supported with USAID funds in USAID/LAC and BFS Activities. These pesticides are enumerated, above.
Pesticide “support” = use of USAID funds to: purchase pesticides; directly fund the application of pesticides; recommend pesticides for use; or purposely facilitate or enable the application or purchase of pesticides via provision of application equipment, credit support, or other means.
- In the case of value chain projects or projects otherwise supporting field crop production, pesticide support must be governed by a set of locally adapted, crop- and pest-specific IPM-based pest management plans and observe enumerated use restrictions. (The PERSUAP provides key information for IPs to develop these plans.)
- Appropriate project staff and beneficiaries must be trained in safer pesticide use and pesticide first aid;
- To the greatest degree practicable, IPs must require that beneficiary farmers use and maintain appropriate PPE and application equipment—as well as implement safe pesticide purchase, handling, storage and disposal practices;
- Projects must be systematic in their pesticide-related record-keeping and monitoring.

These conditions are detailed in the included **mandatory SUAP template** for assigning responsibilities and timelines for implementation of these requirements, and for tracking compliance. Each project subject to this PERSUAP must submit a completed SUAP template to its AOR/COR and provide an annual update.

With respect to pesticides, the SUAP satisfies the requirement for an EMMP for activities involving pesticides. The project EMMP should simply incorporate the SUAP by reference.

In addition, for subject value chain projects or projects otherwise supporting field crop production, the COR, Mission Environmental Officer (MEO) and/or Regional Environmental Advisor (REA) must at least two times annually, make inspection visits to several randomly selected farms receiving project assistance to check for compliance with the SUAP.

Update the Programmatic PERSUAP Annually and Amend the PERSUAP in 2016

New pesticides and EPA registrations change weekly. Lists of registered pesticides in Latin America and Caribbean (LAC) countries are updated annually. In addition, new human health and environmental toxicological data is produced continuously. For these reasons this PERSUAP should be updated at least annually, to reflect changes in pesticide registration status, and toxicological data, and amended after two years to reflect changes in USAID activities where pesticides are used, in order for it to remain current, accurate and in compliance with 22 CFR 216.3.

SECTION 1: INTRODUCTION

This section introduces the purpose, scope, compliance context and methodology of the 2014 Programmatic Pesticide Evaluation Report and Safe Use Action Plan (PERSUAP) for Coffee, with Emphasis on Coffee Rust.

1.1 Purpose, Scope and Orientation

Purpose

To maintain compliance with USAID's Pesticide Procedures (22 CFR 216.3(b)), this 2014 Programmatic PERSUAP for the Bureau for Latin America and Caribbean (LAC) and Bureau for Food Security (BFS) Coffee Support Programs, Projects and Activities:

- Establishes the active ingredients (AIs) in pesticides registered in and recommended by LAC countries for which support is authorized for 'use' (see below) on USAID programs, projects and activities.
- Establishes requirements associated with support for these pesticides to assure that pesticide use/support is (1) within an integrated pest management (IPM) framework, per USAID policy, and (2) embodies the principles of safe pesticide use.

These requirements come into effect upon approval of the PERSUAP.

Scope

This PERSUAP document addresses LAC programs, projects, and activities of implementing partners (IPs), and the IP's sub-grantees, partners, financiers and beneficiaries.

Orientation

The set of authorized pesticide AIs and requirements for safe use are established through Section 3 of the document, the Pesticide Evaluation Report (PER), which assesses the 12 pesticide risk evaluation factors (Factors A through L) required by 22 CFR 216.3(b).

The Safe Use Action Plan (SUAP) in Section 4 provides a succinct, stand-alone statement of compliance recommendations for risk reduction, synthesized from the 12-factor analysis. It also provides a template for assigning responsibilities and timelines for implementation of these requirements.

1.2 Regulation 216

From 1974 to 1976, over 2,800 Pakistan malaria spray personnel were poisoned (5 to death) by insecticide mishaps on a USAID/WHO anti-malaria program². USAID was sued by a coalition of environmental groups and, in response to the lawsuit, drafted 22 CFR 216 (Reg. 216). According to Reg. 216, all USAID activities are subject to analysis and evaluation via – at a minimum – an Initial Environmental Examination (IEE), and – at a maximum – an Environmental Assessment (EA). For the past 13 years, IEEs have been produced for coffee value chain activities in LAC

² <http://www.ncbi.nlm.nih.gov/pubmed/74508>

countries. PERSUAPs have also been written, as recommended by these IEEs, to address support for the promotion and use of good agricultural practices (GAPs) and IPM measures, including the choice and use of natural and synthetic pesticides. This 2014 PERSUAP consolidates best practices known to date, in order to deal with a coffee rust emergency, and it evaluates all potential fungicides and herbicides that are available for use.

A large part of Reg. 216 – Part 216.3 – is devoted to pesticide use and safety. Part 216.3 requires that if USAID is to provide support for pesticides in a project, twelve pesticide factors must be analyzed and recommendations must be written to mitigate or reduce risks to human health and environmental resources. This plan must be followed up with appropriate training, monitoring and reporting for continuous improvement on risk reduction. The adoption of international best practices for crop production, protection and pesticide use safety is strongly encouraged.

Pesticide Definition

For the purposes of this PERSUAP, the word *pesticide* is used, following the U.S. Environmental Protection Agency's (EPA's) guidelines³, for the following: fumigants, insecticides, miticides/acaricides, nematicides, molluscicides, fungicides, antimicrobials, bactericides/biocides, microbicides/antibiotics, herbicides, rodenticides, avicides, algicides, ovicides, disinfectants/sanitizers and anti-fouling agents. Even biological agents such as biopesticides, microbial pesticides, repellents, attractants/pheromones, defoliants, desiccants and insect growth regulators are included as pesticides.

Many IPs believe that “natural” or “organic” chemicals like neem seed extract do not fall under a PERSUAP's purview, but in fact they do. All substances put onto a plant to control pests, including insecticidal soaps, oils, natural minerals and extracts from naturally occurring soil bacteria and plants are considered to be pesticides by EPA and USAID. Therefore all are analyzed by a PERSUAP for EPA and Reg. 216 compliance.

USAID “Support for Pesticide Use”

“Support for pesticide use” was defined and agreed upon at the outset of this PERSUAP study as potentially including:

- Support through direct or indirect (e.g., finance schemes or by sub grantees/partners) purchase of pesticides using USAID resources.
- Support for promotion or use of pesticides, application equipment, or Personal Protection Equipment (PPE) during training of farmers and/or on demonstration farms/activities.
- Any technical assistance to agricultural production systems that includes the use of pesticides, no matter who purchases the pesticide.

This “support” includes any by USAID-funded programs, projects, and activities executed by IPs, as well as by the IP's sub-grantees, partners, financiers and beneficiaries. Pesticides *rejected* by this PERSUAP analysis cannot be ‘supported or used’ for any of the above project activities, unless an EA is performed and concludes their use to be appropriate.

³ <http://www.epa.gov/pesticides/about/types.htm>

1.3 The PERSUAP

In the late 1990s, USAID developed the PERSUAP as a tool to analyze the pesticide system or sector in any given country or territory. The PERSUAP tool focuses on the particular circumstances, crops, pests and IPM/pesticide choices of a project or program. This approach analyzes the pesticide sector or system from registration to import through use to disposal, and develops a location-specific pesticide risk profile based on the analysis. A PERSUAP is generally recommended by and submitted as an amendment to the project IEE or an EA.

1.4 Integrated Pest Management—USAID Policy

In 1990, USAID adopted the philosophy and practice of IPM as official policy. IPM is also strongly promoted and required as part of Reg. 216.3. Since the early 2000s, IPM—which includes judicious and safe use of pesticides—has been an integral part of GAPs and is increasingly considered to constitute best management practices in agriculture.

A definition of IPM from University of California (UC)-Davis⁴ follows:

“Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials [pesticides] are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.”

1.5 Methodology

The development of the 2014 Programmatic PERSUAP for Coffee, with Emphasis on Coffee Rust began in the fall of 2013 with deskwork to identify known information about coffee rust. The authors reviewed LAC PERSUAPs produced in the past five years for each coffee-producing target country to collect information on IPM tools used and recommended as well as fungicides used or recommended. World Coffee Research (WCR), supported by USAID coffee research funds, was contacted. To observe the coffee rust situation and response first-hand, as well as to collect opinions from coffee sector experts, in April and May 2014, Alan Schroeder and Manfredo López Pineda made field visits to sites in Nicaragua and Colombia. In May 2014, Schroeder and Jeannette Dominguez Aristy made field visits to sites in the Dominican Republic. López Pineda also contacted and visited coffee organizations in Guatemala during the study. A questionnaire was sent to coffee organizations in the LAC countries which were not visited. During each visit, the team interviewed USAID staff, the national coffee promotion organizations, officials from the Ministries of Agriculture (MOA), specialty coffee exporters, coffee researchers, and agriculture input shops, as well as farmers and coffee farms/plantations of various sizes.

Hawaii is the only USA state where coffee is produced, and a fraction of all pests and diseases present in LAC countries are present there. Thus, pesticides registered by EPA specifically for

⁴ <http://www.ipm.ucdavis.edu/IPMPROJECT/about.html>

use on the full range of coffee pests (as those present in LAC countries) are limited by this fact. Thus, the study looked at the range of chemicals used for each pest or disease

The PERSUAP contains many links to websites describing agriculture and pesticide best practices, both to make the PERSUAP easier to use (reducing the report's length and thickness) and to provide up-to-date accurate information (as websites are updated continually, but static information is not). As much as possible, the numerous annexes containing pesticide safety equipment recommendations or safe pesticide use practices typically included in a PERSUAP, have been replaced by hot-linked websites. **However, if USAID/LAC-supported project participants do not have access to the Internet, the projects should reproduce and distribute key updated information in written form.**

SECTION 2: BACKGROUND

2.1 Country Backgrounds and Pesticide Registries

To limit the length of the PERSUAP the backgrounds for each coffee producing LAC country are not included here. Instead the reader is referred to the existing LAC PERSUAPs for background information on coffee production, constraints and pesticide use. (Please see the Environmental Compliance Database for these documents: <http://gemini.info.usaid.gov/egat/envcomp/>).

The LAC countries do not publish lists of approved pesticides on the internet, with the exception of Columbia. Colombia makes its list of registered pesticides publicly available on its website: <http://www.ica.gov.co/getdoc/d3612ebf-a5a6-4702-8d4b-8427c1cdaeb1/REGISTROS-NACIONALES-PQUA-15-04-09.aspx>.

2.2 Coffee Species

Among the 125 or so species of plant in the genus *Coffea*⁵, there are two main species cultivated commercially, as follow:

- *Coffea arabica* - **Arabica coffee, native to southwestern Ethiopian highlands has smoother quality (less acidic and less bitter), and is grown at higher, cooler altitudes.**
- *Coffea canephora* - **Robusta coffee, native to central African lowlands, has a more bitter cupping quality, and is grown at lower warmer altitudes.**

Both species are pruned to one to two meters to make them easier to harvest. About forty percent of coffee produced in the world is Robusta, grown primarily in Vietnam, Brazil, India, Indonesia and parts of Africa (especially Uganda and Ivory Coast). Robusta has a greater crop yield than Arabica, and contains more caffeine (*i.e.*, 2.7% compared to Arabica's 1.5%⁶). As it is less susceptible to pests and disease⁷, Robusta generally requires much less pesticide use than Arabica and is cheaper to produce. Important differences between Arabica and Robusta coffees are found <http://www.ico.org/botanical.asp>.

Growing Conditions

According to United Nations Conference on Trade and Development (UNCTAD), <http://www.unctad.info/en/Infocomm/Beverages/Coffee-French-version-only/Crop/>, the following conditions are compared for Arabica and Robusta coffees:

	Coffee Robusta	Coffee Arabica
Altitude	Up to 900 meters Maximum: 1500 meters in Uganda	800-2000 meters Maximum: 2800 meters in Ethiopia
Un-pruned plant height	Up to 8 meters	Up to 5-6 meters
Temperature	24 to 30 degrees C	15 to 24 degrees C

⁵ <http://en.wikipedia.org/wiki/Coffea>

⁶ Mark Nesbitt (2005). *The Cultural History of Plants*. Taylor & Francis. p. 177. Retrieved 22 July 2011.

⁷ Benoit Daviron; Stefano Ponte (2005). *The Coffee Paradox: Global Markets, Commodity Trade and the Elusive Promise of Development*. Zed Books. p. 51. ISBN 978-1-84277-457-1.

	Frost will kill Robusta	Frost will kill Arabica
Rain	2000 to 3000 mm per year	1500 to 2000 mm per year

Irrigation: In years of drought, where rainfall falls below 1500mm/year, irrigation could be used to add supplemental water.

Soil: The soil should provide good drainage and a slightly acidic pH as well as a fairly balanced content of potassium, magnesium, calcium and phosphorus.

Lifespan: The *productive* lifespan of a coffee bush/tree is usually twenty to thirty years. Its life cycle can be schematically divided into three phases: growth, maturity and decline, ending with the death of the tree. Pruned and fertilized plants on plantations can live much longer, but productivity suffers with time.

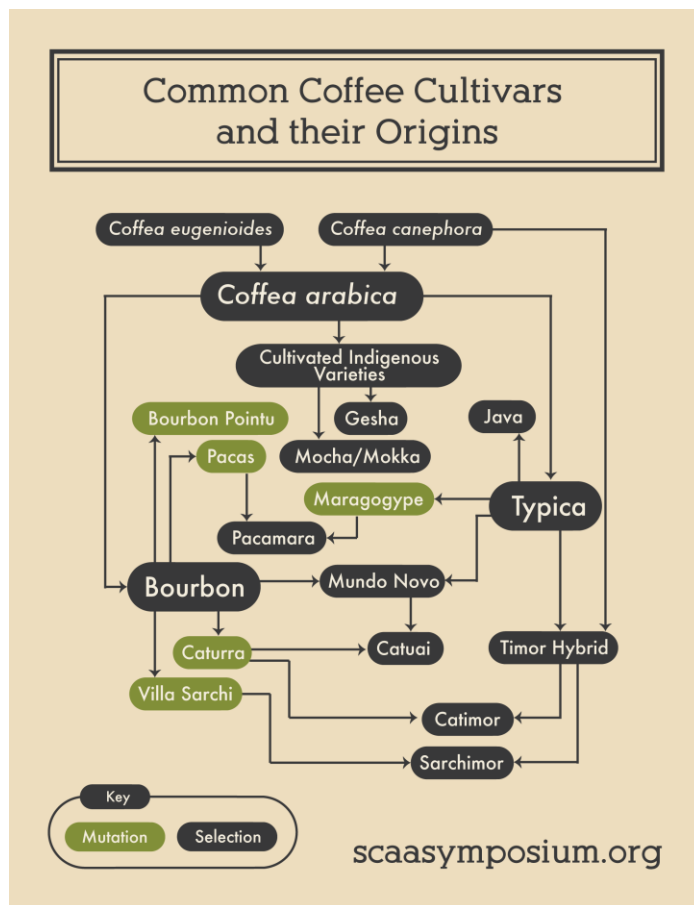


Figure 1: Coffee Cultivar Flowchart⁸

Rust-susceptible varieties include Caturra, Typica, Bourbon and Maragotype. The most common varieties grown in Central American countries are Bourbon, Typica, Caturra and Catuai. In Mexico, Bourbon, Mundo Novo, Caturra, and Maragotype are the most common cultivars. In northern South America (Colombia, Ecuador and Peru) Bourbon, Typica, Caturra, and Maragotype are grown. Catimor and Sarchimor have some resistance to rust and are thus in demand and starting to be grown in the LAC region.

⁸ <http://www.scaasymposium.org/>

A third of all Colombian coffee farms have been renovated with resistant varieties⁹. Colombian farmers plant the resistant variety Castillo; other countries cannot grow it commercially. Colombians also plant Tabi and Colombia, two additional rust resistant varieties that come from the parent Timor, a hybrid of rust susceptible Arabica plants and rust resistant Robusta plants. The cupping quality of rust-resistant varieties is generally different from that of traditional varieties and causes some resistance to their adoption and use. To dilute these effects, Colombian export coffee is now a natural blend of traditional varieties and newer rust resistant varieties.

2.3 Coffee Rusts

The coffee rust pathogen is a basidiomycete¹⁰. There are two species of coffee rust, including:

- *Hemileia vastatrix* - currently found in nearly all the world's coffee-growing regions, including those in Latin America and the Caribbean. This PERSUAP focuses only on this species.
- *Hemileia coffeicola* - restricted to *central and western Africa*, especially the higher and cooler regions.

Infection¹¹

Rust infection occurs through stomata on the underside of the coffee leaf (see Figure 1, below). Urediniospores germinate in the presence of free water (either rain or heavy dew) only—*high humidity alone is not sufficient to lead to germination*. The process of infection requires about 24 to 48 hours of continuous free moisture, so while heavy dew is enough to stimulate urediniospore germination, infection usually occurs only during the rainy season. Variation in rainfall is one of the most important causes of seasonal variation in disease incidence.

Where there are two rainy seasons per year, such as nearer the equator (Colombia, Ecuador), there are two peaks in severity of coffee rust (and two coffee harvests). Infection occurs over a wide range of temperatures (minimum 15°C, optimum 22°C, and maximum 28°C). So, more consistently elevated nighttime temperatures, along with more and more intense rain, may increase infection rates.

Sporulation

Within 10-14 days from infection (spores entering leaf stomata and sprouting mycelia) new uredinia develop and urediniospores are formed. Orange rust lesions enlarge over a period of 2 to 3 weeks (see Figure 3, below) to where they become visible. A single lesion will produce four to six crops of spores, and will release around 300,000 urediniospores over a period of 3 to 5 months. This, combined with secondary cycles of infection that occur continuously during favorable weather, increases the potential for explosive epidemics.

⁹ <http://www.coffeehabitat.com/2011/07/coffee-rust/>

¹⁰ <http://en.wikipedia.org/wiki/Basidiomycota>

¹¹ The descriptions of coffee rust symptoms and the coffee rust life cycle, including Figures 2 and 3, are adapted from the American Phytopathological Society (APS); <http://www.apsnet.org/edcenter/intropp/lessons/fungi/Basidiomycetes/Pages/CoffeeRust.aspx>

Figure 2: Coffee Rust Life Cycle¹²

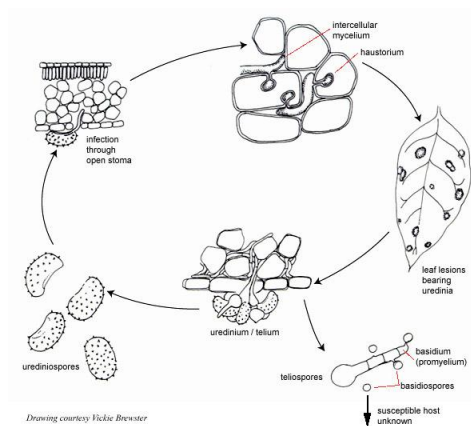


Figure 3: Leaf underside with yellow/orange spores¹³

2.4 Coffee Rust Invasion and Impacts

Coffee rust first appeared in South America in Bahia, Brazil in 1970, followed by Paraguay in 1972, Bolivia in 1978, Peru in 1979, Ecuador in 1981 and Colombia in 1983. In Central America, coffee rust first appeared in Nicaragua in 1976, El Salvador in 1979, Honduras and Guatemala in 1980, Mexico in 1981 and Costa Rica in 1983. In effect, and in general, rust gradually moved west/northwest in both regions, following and likely transported by prevailing trade wind patterns.

Until 2012, rust was an occasional coffee production constraint in most countries and not considered a major threat. But, since the mid-1990s, more farmers have cut shade trees to grow coffee in the sun and boost productivity, or have started new plantations in full sun, leading to a loss of the other beneficial organisms like the White Halo Fungus, *Lecanicillium lecanii*, which likely used to control rust in shade-grown coffee. The small amount of shade-grown coffee decreased 20% during this period. Increases in average ambient temperature¹⁴ as well as unusually high rainfalls at higher altitudes¹⁵, caused by global climate change and warming trends, are pushing intense rain storms, warmer air, and higher nighttime temperatures to higher altitudes in LAC countries. Rust, which used to be found exclusively below 1,750 meters, is now found at altitudes above 2,100 meters.

To paraphrase the American Phytopathological Society (APS), referenced and footnoted above, coffee rust can lead to premature defoliation, which reduces photosynthetic capacity, weakening the tree. Given that next season's berries are produced on this season's shoots; this season's rust infection will reduce the following season's yields. Severe infection can result in dieback of twigs and can, with extreme defoliation, even kill trees.

¹² <http://www.apsnet.org/edcenter/intropp/lessons/fungi/Basidiomycetes/Pages/CoffeeRust.aspx>

¹³ ibid

¹⁴ http://www.nola.com/environment/index.ssf/2014/08/coffee_rust_a_disease_on_the_m.html

¹⁵ <http://worldcoffeeresearch.org/2013/02/08/climate-responsible-for-devastating-coffee-rust-disease-outbreak-in-central-american-countries/>

Currently, in mid-2014, Central American coffee stands have an average of 50% incidence of rust, while very few producers are doing needed coffee stand renovation, like essential replanting, pruning and weeding. It is also anticipated that due to producer and market preferences, as well as access to finance and seedling availability, among other reasons, some producers will retain the traditional coffee varieties (instead of planting resistant ones).

Even though coffee rust is taking a toll on coffee yields throughout LAC countries (and more so on widely-grown Arabica than more resistant Robusta), other countries in other regions are maintaining or increasing yields. Thus, until early 2014, coffee prices and coffee futures markets remain down. A 2013 drought in Brazil reduced production sufficiently to cause coffee futures market prices to double. In terms of overall global coffee output from 2010 to 2013, supplies were increasing fast enough to track increasing demand, and prices remained low, further harming profit potential of smallholders that lost part of their Arabica yield to rust.

2.5 Climate Change and Shade versus Sun Grown Coffee¹⁶

Arabica coffee can produce quality berries only within a narrow higher altitude temperature range of 15 to 24 degrees Celsius¹⁷ in the tropics. As formerly suitable coffee growing altitudes become warmer, due to climate change, farmers are being forced to move production further up mountainsides where it is cooler. An alternative approach to countering these warming trends has been to add shade trees to decrease local temperatures.

A recent study¹⁸ found that although total global production of shade-grown coffee has increased since 1996, the area of land used for non-shade coffee has increased at a much faster rate. The result is that, as a percent of total area cultivated, shade-grown coffee has fallen from 43 percent to 24 percent. Furthermore, most sun-grown coffee is planted in neatly and closely packed rows, with nothing in-between to intercept dispersal of the rust spores from plant to plant. There is some discussion on which cultivation method, sun or shade, may reduce the incidence of coffee rust, as summarized here (see side bar).¹⁹ Field investigations²⁰ appear to show how coffee—a distinctly understory bush with other

SHADE VERSUS SUN GROWN COFFEE

Practitioners debate which cultivation method, sun or shade, helps reduce rust incidence. Coffee rust outbreaks can be greatly influenced by microclimate, making farm- or plantation-wide management decisions challenging. Key discussion points include:

- 1) Coffee plants in full sun dry out quicker following a heavy dewfall or rainstorm, inhibiting the spread of rust.*
- 2) Sunlight and higher temperatures cause coffee plant stomata to open and remain open longer, favoring entry and deep penetration by the rust spores.*
- 3) Fertilized sun-grown coffee produces heavy yields that weaken a plant's defenses, favoring the rust.*
- 4) Increased shade causes the coffee plant to produce larger longer-lasting leaves in order to capture sufficient light for photosynthesis, which allows rust spores more leaf area to colonize and leaf lifetime to be dispersed, favoring the rust.*
- 5) Coffee varieties that are less genetically resistant to rust show lower levels of infection at lower levels of light intensity under shade, favoring the coffee plants.*
- 6) Shade trees intercept raindrops from hitting coffee leaves and dispersing rust spores, favoring the coffee plants.*

¹⁶ <http://www.coffeehabitat.com/2011/07/coffee-rust/>

¹⁷ http://www.ico.org/ecology.asp?section=About_Coffee

¹⁸ <http://bioscience.oxfordjournals.org/content/early/2014/04/14/biosci.biu038.abstract>

¹⁹ <http://www.coffeehabitat.com/2011/07/coffee-rust/>

bushes and trees growing in-between—has been transferred to full sun and high-sun “shade grown” monocultures, a condition that has likely exacerbated the spread of rust.

2.5 Primary Results of Analysis of Coffee Rust GAPs, IPM and Common Sense Actions

The following is a summary of the GAPs, IPM measures and common sense actions noted from interviews with coffee sector experts, both in person in Nicaragua, Colombia and Dominican Republic as well as by phone and email, that are required to promote strong, healthy stands of coffee that will be more able to tolerate or resist coffee rust.

- **Shade:** More than 75% of Arabica coffee grown worldwide is cultivated in full sun or high-sun certified “shade-grown” monocultures. Monocultures are particularly susceptible to disease outbreaks in part because plagues, such as coffee rust, can spread far more quickly over a large area covered by a single crop than in an ecologically diverse community. Taller-tree shade (at least 50%) helps protect coffee plants and soil microclimate from excessive solar radiation and heat, preserving soil moisture. Shade also benefits the white halo fungus, which is a myco-hyperparasite that attacks and kills rust spores, and is an entomopathogen that attacks and kills small sucking pests like the green coffee scale, aphids, thrips and whiteflies.
- **Plantation/Farm Renovation:** Pulling up old plants and planting new vigorous seedlings of local and resistant varieties; plantings older than 25-30 years do not have the strength needed to fight rust and other production constraints; younger plants are stronger.
- **Resistant varieties:** Although cupping quality may change slightly, resistant varieties, along with weeding, pruning and fertilizing, provide some rust prevention/tolerance.
- **Replanting:** Individual new seedlings that are consistently hard-hit by insects or diseases should be pulled up and replaced with other new seedlings.
- **Quality/certified seed/seedling multiplication:** It is important to ensure that coffee seedlings being subsidized or purchased are of the stated variety, age, and health with quality root development. Further, at planting, especially in harder soils, a sufficiently-large hole needs to be dug to accommodate proper root system development. *Subsidy programs used to help purchase new seedlings for smallholders (2 or less ha) should not operate without a seed/seedling certification system in place to guarantee quality.*
- **Weed control:** Weeds compete with coffee plants for nutrients and other resources and need to be controlled.
- **Pruning:** Pruning is necessary as a means to reduce woody growth and over-flowering, especially on seedlings. Over-flowering drains the plant of minerals needed for future production and woody growth (e.g., extra branches) takes plant energy away from cherry production. Additionally, maintenance pruning is beneficial on more mature plants as a means to remove suckers and extra branches, as well as to open canopy for good light and air penetration, and increase ability of parasites and predators of coffee pests to access the plants, further helping decrease pests and diseases. See FAO’s excellent guidelines on pruning coffee at <http://www.fao.org/docrep/006/ad219e/ad219e06.htm>.

²⁰ Over the past four years, University of Michigan (UM) researchers found that growing coffee under shade can facilitate a complex ecological interaction that helps fight coffee rust in Mexico. The green coffee scale, which is a pest of and feeds on coffee, exudes honeydew. A species of ants that nests in shade trees feeds upon this honeydew. While present, the ants defend the scale insects from predators and parasites, favoring the scale. Next, a “white halo fungus” which is present on coffee grown under shade, and not sun, attacks the green coffee scale and kills it. The dead fungus-covered scales serve as a reservoir and source of white halo fungus inoculum, and the ants spread these beneficial spores to other leaves and parts of coffee plants. What is more important is that this white halo fungus also attacks and kills rust spores, favoring the coffee bushes grown under shade. Under full sun and mostly-sun grown coffees, this interaction breaks down and the white halo fungus does not provide the rust control that it does under shade.

- **Cutting:** Older coffee plants should be cut off a few inches above the soil line, so new shoots can grow with vigor and production almost like a new seedling. This practice is predominantly used on commercial plantations in Colombia, and not smallholder farms.
- **Fungicides:** Fungicides can be applied to coffee as 1) preventive or protective contact chemicals, stopping the rust spore from entering and infecting the plant, 2) curative systemic treatments after infection but *before* the infection reaches the sporulation stage (where it is making and releasing new spores—the orange powdery spots on the underside of coffee leaves), and 3) eradicated or anti-sporulative (after onset of visible symptoms).
- **Use of fertilizers:** Fertilizers used appropriately make the plant stronger so that it can fight rust. Fertilizers should be used according to soil test results and after weeding and pruning. Donations of fertilizers should only be done following soil tests, pruning, weeding and cost sharing by farmers. In general, organic fertilizers like manures and compost release their nutrients more slowly and stay in the upper soil layers longer than mineral fertilizers²¹.
- **Mixed cropping with cash crops and fruit trees:** In addition to some shade and increased diversity, mixed cropping, especially for smallholder farmers, provides additional sources of income (e.g., cacao and fruit trees).
- **Intercropping with food crops:** Food security crops like legumes can be planted between rows of newly planted coffee seedlings.
- **Certified coffee farms:** Market-driven voluntary standards and certification systems for coffee drive the adoption and use of good agriculture and integrated pest management practices.
- **Control of abandoned farms:** Abandoned coffee farms that are not maintained or sprayed serve as a reservoir of pests and diseases that spread to surrounding farms. These need to be controlled.
- **Sanitation:** Reduction of disease inoculum and insect pests can be achieved by removing and destroying mummified, infested and fallen berries and rust-infested leaves.
- **Topsoil conservation:** Effective techniques include the use of vegetated buffer strips, green manure, compost, mulching, terracing, employing windbreaks, employing nitrogen-fixing ground covers between rows, and planting coffee rows perpendicular to the slope. Terracing helps keep quality topsoil in place, preventing landslides and providing edge bunds for growing other crops like plantains and bananas.
- **Farm Certification:** Promote the adoption of coffee certification programs for coffee cooperatives and associations, where smallholder farmers are clustered together to share certification and other costs. Independent of factors like certification cost and levels of farmer organization, certification schemes and the oversight that comes with them can help coffee farmers access the necessary technical training to learn how to use pesticides safely and efficiently.
- **Management of coffee berry borer (*la broca*) and other constraints:** Other coffee pests and diseases stress the plant and render its coffee rust defenses weaker. Breeding programs need to include resistance to key pests.
- **Cash Subsidies/Assistance:** Cash subsidies should only be provided in the event that *farmers agree to renovate* a part of their coffee stand with new plants, as well as weed and prune, and follow through. Colombia has a program that implements this practice.²²
- **IPM:** Prior to the purchase and use of natural or synthetic pesticides, the use of non-pesticide IPM tools and tactics for each crop-pest combination (Annex 1) should be promoted. Effective tactics include certified disease-free planting material, monitoring, traps,

²¹ <http://www.dcm-info.com/us/info/380/how-do-organic-fertilizers-differ-from-mineral-fertilizers/>

²² Personal communication from 2014 meetings with Colombia's FEDECAFE

biologicals, and cultural practices (e.g., pruning, weeding, better management of coffee plants and planting, and sanitation).

- **No POPs and PIC Chemicals:** Absolutely no Prior Informed Consent (PIC, <http://www.pic.int>) or Persistent Organic Pollutant (POP, <http://www.pops.int>) chemicals will be used or supported on USAID projects.
- **MSDS and label information:** USAID projects should have on hand pesticide label and Material Safety Data Sheets (MSDS) information for more popular fungicides and herbicides that their beneficiaries use.
- **Pesticide container disposal:** If a national or regional pesticide container recycling facility is available, USAID and project IPs should encourage its use.
- **Training on IPM, Safe Pesticide Use (SPU) and Personal Protection Equipment (PPE):** Train and encourage farmers to purchase inputs from suppliers that provide quality technical support, and to purchase and use PPE, or contract private pesticide spray services.
- **Spray services:** Promote the idea of using spray services that have trained application personnel that know how to properly calibrate sprayers, use quality pesticides, and maintain sprayers, use PPE and have the means for proper disposal of empty containers.

SECTION 3: PESTICIDE EVALUATION REPORT (PER)

3.1 Factor A: USEPA Registration Status of the Proposed Pesticide²³

Fungicides can be applied to coffee as 1) preventive or protective contact chemicals, stopping the rust spore from entering and infecting the plant, 2) curative systemic after infection but *before* infection reaches the sporulation stage (where it is making and releasing new spores—the orange powdery spots on the underside of coffee leaves), and 3) eradivative or anti-sporulative (after onset of visible symptoms).

The use of fungicides represents a longer-term investment. The decision to buy and use fungicides may be expensive, however this is an investment that will carry over and be spread among several seasons, as overall coffee rust inoculum is reduced for several seasons after one season of properly-timed applications.

In order to make this study comprehensive and useful across a range of LAC countries, AIs present in all fungicides potentially used against coffee rust were evaluated. And, since weed management is an important factor in the overall vigor of coffee plants, resulting in stronger plants more resistant to rust, herbicide AIs were also evaluated. The following are the results of these analyses:

Protective contact copper fungicide AIs (non-toxic to humans *at recommended dosages*):

- *Copper hydroxide* or “blue-green copper”, also known as cupric hydroxide, often formulated as Wettable Powder (WP) or as Oil suspension, sometimes combined with zinc). Commercial names Cupravit/Cupravit Azul 35% WP, Kocide 35% WP, Kocide 101 50, 54%, Kocide 220 in oil 14%, Kauritol in oil at 35%, at a usage rates of 7 kg AI/ha.
- *Copper oxychloride* or “green copper”, also known as cupric chloride, most used of the copper compounds, available at 35%, 45%, 50% metallic copper in WP or Oil Suspensions/Dispersion (OD), 1.5 kg AI/1000 plants/ha is considered optimum, however use is not compatible with dithiocarbamates). Commercial names: Cobox, Vitigran concentrate, Recop, Cupravit, Cuprocal, Funguran, and Pereclor, all at 50% WP and used at 3.8 kg per hectare ²⁴)
- *Cuprous oxide* or “red copper”, applied at 1.9-3.0 kg AI/ha, a microgranular (GR) formulation is best. Commercial names: Copper-Sandoz M2 50% WP used at 1.9% AI/ha, Copper Nordox 50% WP, Champion 50% WP, Kocide) used at 3-3.8 kg/ha; and Nordox Super 75 WP or Nordox 75 Water Dispersible Granules (WG) at 2.4kg/ha.

Protective contact copper plus sulfur fungicide AIs (non-toxic to humans *at recommended dosages*):

- *Tribasic copper sulfate* at 53% AI. Commercial name Cobre Sana WP 42%, Benz Cobre WP 20%, usage rate information not available)
- *Copper (II) sulfate pentahydrate plus calcium hydroxide/lime*. Known as Bordeaux mixture, see below, applied at 0.5-1.5% solutions.

²³ See Annex 2 for registration and restriction information

²⁴ Ajjamada C. Kushalappa and Albertus B. Eskes, 1989, Coffee Rust Epidemiology, Resistance and Management, CRC Press, Inc.

The use of protective contact copper compounds has the following advantages:

- Copper has a tonic effect, increasing coffee yields, independent of rust control. Copper is an essential micronutrient, and its application extends leaf retention and therefore boosts tree growth and yield.
- Copper compounds stick to and stay on leaves well during rainstorms.
- Copper is considered broad-spectrum, so it is difficult for fungal pathogens to develop resistance.
- Copper compounds will control more diseases than just rust; the broad-spectrum nature is useful against other coffee diseases like bacterial blight of coffee (BBC) and coffee berry disease (CBD).
- Copper compounds are generally less expensive than systemic fungicides.

And, the use of protective contact copper compounds has the following disadvantages:

- Need to know forecast and actual weather (rainfall, temperature) information.
- Short time frame within which to react: Prediction of rust is based on past presence and amount of rust, rainfall and temperature. This needs to be precise as rust can infect a plant within 48 hours of optimal weather conditions, and copper needs to be present on the undersides of leaves before rust infection occurs.
- Soil Toxicity: Copper accumulates in the soil organic matter. At higher levels of accumulation, it can become toxic to coffee plants as well as soil microbes needed for coffee plant nutrition. Each country's MOA should have recommended best practices for determining the acceptable levels of copper in soil samples. Field project managers and implementers will need to check with their MOA to determine this level and ensure that soil tests are performed.

Protective contact carbamates/dithiocarbamate AIs (bulleted in italics)

Dithiocarbamates act by inhibiting fungal energy production, disrupting cellular lipid metabolism and production, respiration, and thus fungal activity.

Dialkyl-dithiocarbamate AIs

ferric derivative

- *ferbam*, stable under hot humid conditions, use at 0.4% in coffee nursery

zinc derivative

- *ziram*, use at 0.75 L AI/ha

Bis-dithiocarbamate AIs

manganese derivative

- *maneb*, also known as manganous-ethlenebisdithiocarbamate. Commercial name Manzate, use at 1.6 kg AI/ha

zinc derivative

- *zineb*, also known as zinc-ethylene bisdithiocarbamate (**not EPA registered—do not promote or use with USAID support**)

zinc ion of maneb

- *mancozeb*, Commercial name Dithane M-45 80% WP, Suspension Concentrate (SC), WG, but does not perform as well as maneb, thus mancozeb is not recommended for use on coffee rust

The use of protective contact dithiocarbamates has the following disadvantages:

- Dithiocarbamates are easily washed off by rain, have short residual affect due to chemical instability at higher solar radiation and humidity. And, some quickly decompose under storage.

Other types or classes of protective contact fungicide AIs (bulleted in italics)

Pyrimidine AI

- *dithianon*, Commercial name Delan 75% WP and Delan 50% SC, use at 3.3 kg/ha) **(not EPA registered—do not promote or use with USAID support)**

Organotin AI

- *fentin hydroxide* (**EPA RUP—do not promote or use with USAID support**)

Phthalimide AIs (act by inhibiting germination of spores)

- *captan*
- *captafol* **(not EPA registered—do not promote or use with USAID support)**

Curative systemic fungicide AIs (bulleted in italics)

Anilide AI (inhibit fungal respiration and spore germination)

- *pyracarbolid* **(not EPA registered—do not promote or use with USAID support)**

Dicarboxamide AI (inhibit fungal nucleic acid biosynthesis)

- *oxycarboxyn*, Commercial name Plantvax 5GR (Granular), oxycarboxin 20% EC (Emulsifiable Concentrate) applied at 1-2 L/ha; not as effective as triademifon

Azoles (disrupt fungal ergosterol biosynthesis and membrane function, broad spectrum)

- *cyproconazole*, Commercial name Alto 10% SL (Soluble Liquid), mix at 10 ml in 10 liters, apply at 0.5 liter/ha)
- *epoxiconazole* **(not EPA registered—do not promote or use with USAID support)**
- *hexaconazole* **(not EPA registered—do not promote or use with USAID support)**
- *propiconazole*, available commercially at 25% SC, apply in a mixture with a copper compound near end of disease cycle, use at 250 g AI/ha, or 1 kg commercial product/ha; for Granular soil applications, use 1.5-2 g/plant)
- *tebuconazole*, formulated at 25% EC, use at 1-2 L/ha

Triazoles (inhibit fungal biosynthesis of ergosterol, necessary for fungal cell wall formation)

- *flutriafol*, formulated at 1% G, use at 19 g/tree.
- *myclobutanil*, mentioned in 2 articles, but no formulation or usage information is given
- *triadimefon*, Commercial name Bayleton 25% WP or dry flowable, 1 liter per hectare (0.2 - 0.6 kg AI/1000 plants/ha), however, use of triadimefon may stimulate Coffee Berry Disease; 50% WP formulation use at 2 kg/ha; for soil applications, 0.5 - 1.0 kg/1000 plants/ha.
- *triadimenol*, also known as triadimefon breakdown product, 1% G, use at 20-30 g/tree. Commercial names Baytan 30% and Trilex Advanced, mixtures with 2 other AIs.

Benzimidazole (systemic with protectant and eradicant activity. Inhibition of mitosis and cell division)

- *benomyl* **(not EPA registered—do not promote or use with USAID support)**

- *carbendazim* (not EPA registered for same or similar use—do not promote or use with USAID support)

Strobilurins (systemic translaminar and protectant action having additional curative and eradicant properties. Inhibits fungal respiration)

- *azoxystrobin*, 4.6%
- *pyraclostrobin*, 85 g/l mixed with epoxiconazole 62.5 g/L, Commercial name: Opera, use at 1.5 L/ha
- *trifloxystrobin*, 375 g/L mixed with cyproconazole 160 g/L, Commercial name: Sphere Max

Organophosphate (systemic, with both curative and protective properties. Absorbed through roots and translocated. Phospholipid biosynthesis inhibitor)

- *fosetyl aluminum*, formulated at 80% WP, use at 2-3 kg/ha

Systemic fungicides have the following advantages:

- Often broad-spectrum, so they kill other diseases/pests in addition to rust.
- Have protective as well as eradicative properties.
- Systemic fungicides are useful particularly during off-season rains and continuous flowering, as both curative and eradicative.

Systemic fungicides have the following drawbacks:

- Higher relative cost.
- Potential severe defoliation if dosages and rates of use are not followed.

Herbicide AIs

- *2,4-D*
- *ametryne*
- *clethodim*
- *dalapon-sodium* (not EPA registered—do not promote or use with USAID support)
- *diuron* (known carcinogen, known ground water pollutant—do not promote or use with USAID support)
- *flazasulfuron*
- *fluazifop-p-butyl*
- *fomasafen-sodium*
- *glyphosate*
- *oryzalin*
- *oxyfluorfen*
- *paraquat* (EPA RUP, Class I—do not promote or use with USAID support)
- *pelargonic/nonanoic acid*
- *sethoxydim*

The use of herbicides has the following advantage and disadvantage:

- Advantage: Quicker weed control than manual labor by chopping.
- Disadvantage: Costs can be too high for smallholders, and the massive immediate loss of weeds and roots can lead to loss of topsoil due to erosion and landslides during rainstorms.

The following tables summarize fungicide, herbicide, insecticide and nematocide recommendations, findings and rejections from the PER Factor A analyses, above.

Primary Results of Analyses of *Coffee Rust* Fungicides

Protective contact fungicide and copper bactericide AIs in products used to help prevent coffee rust from entering leaves.

The following are recommended by this PERSUAP for Bureau Environmental Officer (BEO) approval for use in USAID Projects, with the condition that *fungicides containing these active ingredients must be registered in the target country, and that label instructions must be followed.*

Copper and copper/sulfur compounds (allowed for most organic certification systems)

- Bordeaux mixture (copper (II) sulfate pentahydrate plus calcium hydroxide/lime)
- copper hydroxide “blue-green copper”
- cuprous oxide or “red copper”
- copper oxychloride or “green copper”, also known as cupric chloride
- tribasic copper sulfate or “blue copper”

Carbamates/Dithiocarbamates and others (not allowed for organic production)

- ferbam
- mancozeb
- maneb
- ziram

Curative systemic fungicide AIs in products used to help cure or eradicate established rust mycelia from coffee plants.

The following are recommended by this PERSUAP for BEO approval for use in USAID Projects, with the condition that *label instructions must be followed.*

- azoxystrobin
- captan
- cyproconazole
- flutriafol
- fosetyl aluminum
- myclobutanil
- oxycarboxyn
- propiconazole
- pyraclostrobin
- tebuconazole
- triadimefon
- triadimenol
- trifloxystrobin

Protective contact fungicide AIs in products used to help prevent coffee rust.

The following are recommended by this PERSUAP for BEO REJECTION (*with reason for rejection*).

- captafol (**not EPA registered—do not promote or use with USAID support**)
- dithianon (**not EPA registered—do not promote or use with USAID support**)
- fentin hydroxide (**RUP—do not promote or use with USAID support**)
- zineb (**not EPA registered—do not promote or use with USAID support**)

Curative systemic fungicide AIs in products known to be used to help cure or eradicate established rust mycelia from coffee plants.

The following are recommended by this PERSUAP for BEO REJECTION (*with reason for rejection*).

- benomyl (**not EPA registered—do not promote or use with USAID support**)
- carbendazim (**not EPA registered for agriculture—do not promote or use with USAID support**)
- chlorothalonil (**Class I eye toxin**)
- epoxiconazole (**not EPA registered—do not promote or use with USAID support**)
- hexaconazole (**not EPA registered—do not promote or use with USAID support**)
- pyracarbolid (**not EPA registered—do not promote or use with USAID support**)

Primary Results of Analyses of Coffee Herbicides

Although this PERSUAP deals primarily with coffee rust and the fungicides used to manage it, weed control is important for coffee plant health leading to better rust management, especially on large holder plantations. For this reason, common coffee plantation herbicides are also analyzed. Smallholders often cannot afford or will not use herbicides. Instead they cut or chop the weeds with sharp machetes, which is actually a preferred weed control practice.

Herbicide AIs in products used to control weeds in coffee.

The following are recommended by this PERSUAP for BEO approval for use in USAID Projects, with the condition that *label instructions* must be followed.

- 2,4-D
- ametryne
- clethodim
- flazasulfuron
- fluazifop-p-butyl
- fomesafen-sodium
- glyphosate
- oryzalin
- oxyfluorfen
- pelargonic/nonanoic acid
- sethoxydim

Herbicide AI in products used to control weeds in new coffee plantations.

The following are recommended by this PERSUAP for BEO REJECTION (*with reason for rejection*).

- dalapon-sodium (**not EPA registered—do not promote or use with USAID support**)
- diuron (**known carcinogen, known ground water pollutant—do not promote or use with USAID support**)
- paraquat (**RUP, Class I—do not promote or use with USAID support**)
- simazine (**known groundwater pollutant**)

Primary Results of Analyses of Coffee Fungicides for Diseases Other than Rust

Fungicide AIs in products used to help manage coffee fungal diseases.

The following are recommended by this PERSUAP for Bureau Environmental Officer (BEO) approval for use in USAID Projects, with the condition that *fungicides containing these active ingredients must be registered in the target country, and that label instructions must be followed*

- azoxystrobin
- Bordeaux mixture (copper (II) sulfate pentahydrate plus calcium hydroxide/lime)
- captan
- copper hydroxide or “blue-green copper”
- cuprous (cuprous) oxide or “red copper”
- copper oxychloride or “green copper”, also known as cupric chloride
- copper sulfate (tribasic) or “blue copper”
- cyproconazole
- ferbam
- folpet
- mancozeb
- maneb
- mineral oil
- neem seed oil
- propiconazole
- *Pseudomonas fluorescens*
- sodium bicarbonate
- sulfur
- tebuconazole
- thiabendazole
- thiophanate methyl
- thiram
- triadimenol
- *Trichoderma harzianum*

Fungicide AIs in products used to help manage coffee diseases.

The following are recommended by this PERSUAP for BEO rejection (with reason for rejection).

- benomyl (not EPA registered—do not promote or use with USAID support)
- captafol (not EPA registered—do not promote or use with USAID support)
- carbendazim (not EPA registered for agriculture—do not promote or use with USAID support)
- chlorothalonil (Class I eye toxin)
- cypendazole (not EPA registered—do not promote or use with USAID support)
- dithianon (not EPA registered—do not promote or use with USAID support)
- hexaconazole (not EPA registered—do not promote or use with USAID support)
- propineb (not EPA registered—do not promote or use with USAID support)
- tridemorph (not EPA registered—do not promote or use with USAID support)

Primary Results of Analyses of Coffee Insecticides

Insecticide AIs in products used to help manage coffee insect pests.

The following are recommended by this PERSUAP for Bureau Environmental Officer (BEO) approval for use in USAID Projects, with the condition that *fungicides containing these active ingredients must be registered in the target country, and that label instructions must be followed.*

- *Beauveria bassiana*
- capsaicin/chili pepper extract
- carbaryl
- cyromazine
- dimethoate
- imidacloprid
- insecticidal soap (potassium salts of fatty acids)
- malathion
- mineral oil
- neem oil
- permethrin
- spinetoram
- spinosad
- spirotetramat
- spiromesifen
- spirotetramat
- thiamethoxam

Insecticide AIs in products used to help manage coffee insect pests.

The following are recommended by this PERSUAP for BEO REJECTION (with reason for rejection).

- aldicarb (RUP—do not promote or use with USAID support)
- beta-cypermethrin (RUP—do not promote or use with USAID support)
- bifenthrin (RUP—do not promote or use with USAID support)
- carbofuran (RUP—do not promote or use with USAID support)
- carbosulfan (not EPA registered—do not promote or use with USAID support)
- chlorpyrifos (ethyl) (not EPA registered for agriculture—do not promote or use with USAID support)
- deltamethrin (a few formulations RUP for use on cotton)
- diazinon (all horticulture uses RUP—do not promote or use with USAID support)
- endosulfan (banned internationally on POPs treaty—do not promote or use with USAID support)
- fenitrothion (not EPA registered for agriculture—do not promote or use with USAID support)
- lambda-cyhalothrin (RUP—do not promote or use with USAID support)
- methomyl (RUP—do not promote or use with USAID support)
- oxamyl (RUP—do not promote or use with USAID support)

Primary Results of Analyses of Coffee Nematicides

Nematicide AIs in products used to help manage coffee nematode pests.

The following are recommended by this PERSUAP for Bureau Environmental Officer (BEO) approval for use in USAID Projects, with the condition that *fungicides containing these active ingredients are registered in the target country, and that label instructions are followed*

- allyl isothiocyanate (mustard oil)
- *Bacillus firmus*
- capsaicinoids (chili pepper extract)
- *Myrothecium verrucaria*
- *Paecilomyces lilacinus* Strain 251
- tomatillo oil + thyme oil extracts (USA commercial product called Promax)

Nematicide AIs in products used to help manage coffee nematode pests.

The following are recommended by this PERSUAP for BEO REJECTION (with reason for rejection).

- 1, 3 dichloropropene (RUP—do not promote or use with USAID support)
- aldicarb (RUP—do not promote or use with USAID support)
- cadusafos (not EPA registered—do not promote or use with USAID support)
- carbofuran (RUP—do not promote or use with USAID support)
- carbosulfan (not EPA registered—do not promote or use with USAID support)
- metam sodium (RUP—do not promote or use with USAID support)
- oxamyl (RUP—do not promote or use with USAID support)

- | |
|---|
| <ul style="list-style-type: none">• terbufos (RUP—do not promote or use with USAID support) |
|---|

Compliance Requirements

- USAID LAC projects will need to use care to apply insecticide that contain neonicotinoid AIs like imidacloprid and thiamethoxam at times other than flowering to avoid potential harm to honeybee pollinators.
- USAID LAC projects will not promote, finance or use on demonstration farms, pesticides not registered by EPA for same or similar use, those classified by EPA as RUP products, or those deemed too toxic for smallholder farmers to use.
- If USAID LAC projects wish to request the support of any non-EPA registered or RUP product, including use on any demonstration farm, then a full EA must be done and approved by the LAC BEO.
- USAID LAC projects shall obtain and retain copies of the MSDS for each pesticide that their beneficiary farmers use frequently.

3.2 Factor B: Basis for Selection of Pesticides

Field visits and research found that farmers in LAC countries choose pesticides based primarily upon the price, efficacy and availability of products in quantities they desire and can afford. They also use advice of agrodealers, extension agents and neighbors.

Recommendations:

- Farmers should be trained by USAID-supported IPs/partners/sub-grantees on how to choose the correct pesticide, instead of relying upon the advice of agrodealers and neighbors.
- Use training to encourage farmers to use products with lower human and ecological toxicities (see Annex 2) if there is a choice.

3.3 Factor C: Extent to which the Proposed Pesticide Use Is, or Could Be, Part of an IPM Program

Every extension service contacted has and promotes a coffee Pest Management Plan (PMP) with preventive GAP/IPM tools and tactics that should be integrated and used before pesticides are used. Most commercial plantation farms implement most of the best practices recommended. However, in most countries there are insufficient resources to reach many of the smallholder farms and farmers with this information²⁵. The analyzed, accepted, and recommended pesticides are listed in the IPM matrix, in Annex 1. The IPM matrix also includes the economic injury level (EIL) for each pest.

The following is a summary of the GAPs, IPM measures and common sense actions noted during interviews with coffee sector experts, both in person in Nicaragua, Colombia and Dominican Republic as well as by phone and email, that promote strong, healthy stands of coffee that will be more able to tolerate or resist coffee rust.

²⁵ Meeting notes from MOAs of Colombia, Nicaragua and Dominican Republic

- **Shade:** More than 75% of Arabica coffee grown worldwide is cultivated in full sun or high-sun certified “shade-grown” monocultures. In contrast Arabica coffee evolved in Ethiopia as an Understory Shrub. Monocultures are particularly susceptible to disease outbreaks in part because plagues, such as coffee rust, can spread far more quickly over a large area covered by a single crop than in an ecologically diverse community. Taller-tree shade (at least 50%) helps protect coffee plants and soil microclimate from excessive solar radiation and heat, preserving soil moisture. Shade also benefits the white halo fungus, which is a myco-hyperparasite that attacks and kills rust spores, and is an entomopathogen that attacks and kills small sucking pests like the green coffee scale, aphids, thrips and whiteflies.
- **Plantation/Farm Renovation:** Pulling up old plants and planting new vigorous seedlings of local and resistant varieties; plantings older than 25-30 years do not have the strength needed to fight rust and other production constraints; younger plants are stronger.
- **Resistant varieties:** Although cupping quality may change slightly, resistant varieties, along with weeding, pruning and fertilizing, provide some rust prevention/tolerance.
- **Replanting:** Individual new seedlings that are consistently hard-hit by insects or diseases should be pulled up and replaced with other new seedlings.
- **Quality/certified seed/seedling multiplication:** It is important to ensure that coffee seedlings being subsidized or purchased are of the stated variety, age, and health with quality root development. Further, at planting, especially in harder soils, a sufficiently-large hole needs to be dug to accommodate proper root system development. *Subsidy programs used to help purchase new seedlings for smallholders (2 or less ha) should not operate without a seed/seedling certification system in place to guarantee quality.*
- **Weed control:** Weeds compete with coffee plants for nutrients and other resources and need to be controlled.
- **Pruning:** Pruning is necessary as a means to reduce woody growth and over-flowering, especially on seedlings. Over-flowering drains the plant of minerals needed for future production and woody growth (e.g., extra branches) takes plant energy away from cherry production. Additionally, maintenance pruning is beneficial on more mature plants as a means to remove suckers and extra branches, as well as to open canopy for good light and air penetration, and increase ability of parasites and predators of coffee pests to access the plants, further helping decrease pests and diseases. See FAO’s excellent guidelines on pruning coffee at <http://www.fao.org/docrep/006/ad219e/ad219e06.htm>.
- **Cutting:** Older coffee plants should be cut off a few inches above the soil line, so new shoots can grow with vigor and production almost like a new seedling. This practice is predominantly used on commercial plantations in Colombia, and not smallholder farms.
- **Fungicides:** Fungicides can be applied to coffee as 1) preventive or protective contact chemicals, stopping the rust spore from entering and infecting the plant, 2) curative systemic treatments after infection but *before* the infection reaches the sporulation stage (where it is making and releasing new spores—the orange powdery spots on the underside of coffee leaves), and 3) eradivative or anti-sporulative (after onset of visible symptoms).
- **Use of fertilizers:** Fertilizers make the plant stronger so that it can fight rust. Fertilizers should be used according to soil test results and after weeding and pruning. Donations of fertilizers should only be done following soil tests, pruning, weeding and cost sharing by farmers. In general, organic fertilizers like manures and compost release their nutrients more slowly and stay in the upper soil layers longer than mineral fertilizers²⁶.
- **Mixed cropping with cash crops and fruit trees:** In addition to some shade and increased diversity, mixed cropping, especially for smallholder farmers, provides additional sources of income (e.g., cacao and fruit trees).

²⁶ <http://www.dcm-info.com/us/info/380/how-do-organic-fertilizers-differ-from-mineral-fertilizers/>

- **Intercropping with food crops:** Food security crops like legumes can be planted between rows of newly planted coffee seedlings.
- **Certified coffee farms:** Market-driven voluntary standards and certification systems for coffee drive the adoption and use of good agriculture and integrated pest management practices.
- **Control of abandoned farms:** Abandoned coffee farms that are not maintained or sprayed serve as a reservoir of pests and diseases that spread to surrounding farms. These need to be controlled.
- **Sanitation:** Reduction of disease inoculum and insect pests can be achieved by removing and destroying mummified, infested and fallen berries and rust-infested leaves.
- **Topsoil conservation:** Effective techniques include the use of vegetated buffer strips, green manure, compost, mulching, terracing, employing windbreaks, employing nitrogen-fixing ground covers between rows, and planting coffee rows perpendicular to the slope. Terracing helps keep quality topsoil in place, preventing landslides and providing edge bunds for growing other crops like plantains and bananas.
- **IPM:** Prior to the purchase and use of natural or synthetic pesticides, the use of non-pesticide IPM tools and tactics for each crop-pest combination (Annex 1) should be promoted. Effective tactics include certified disease-free planting material, monitoring, traps, biologicals, and cultural practices (e.g., pruning, weeding, better management of coffee plants and planting, and sanitation).
 - **No POPs and PIC Chemicals:** Absolutely no Prior Informed Consent (PIC, <http://www.pic.int>) or Persistent Organic Pollutant (POP, <http://www.pops.int>) chemicals will be used or supported on USAID projects.
 - **Farm Certification:** Promote the adoption of coffee certification programs for coffee cooperatives and associations, where smallholder farmers are clustered together to share certification and other costs. Independent of factors like certification cost and levels of farmer organization, certification schemes and the oversight that comes with them can help coffee farmers access the necessary technical training to learn how to use pesticides safely and efficiently.
 - **MSDS and label information:** USAID projects should have on hand pesticide label and Material Safety Data Sheets (MSDS) information for more popular fungicides and herbicides that their beneficiaries use.
 - **Pesticide container disposal:** If a national or regional pesticide container recycling facility is available, USAID and project IPs should encourage its use.
 - **Training on IPM, Safe Pesticide Use (SPU) and Personal Protection Equipment (PPE):** Train and encourage farmers to purchase inputs from suppliers that provide quality technical support, and to purchase and use PPE, or contract private pesticide spray services.
- **Spray services:** Promote the idea of using spray services that have trained application personnel that know how to properly calibrate sprayers, use quality pesticides, and maintain sprayers, use PPE and have the means for proper disposal of empty containers.
- **Pesticide mixing stations:** In instances where pesticide mixing stations are far (at least 30 meters) from water point sources and bodies, a shower and spout should be installed at the mixing place over a graveled base, with carbon or compost in the soil under the mixing station, in a location within the coffee plot.
- **Management of coffee berry borer (la broca) and other constraints:** Other coffee pests and diseases stress the plant and render its coffee rust defenses weaker. Breeding programs need to include resistance to key pests.

- **Cash Subsidies/Assistance:** Cash subsidies should only be provided in the event that *farmers agree to renovate* a part of their coffee stand with new plants, as well as weed and prune, and follow through. Colombia has a program that implements this critical practice.²⁷

Recommendations

- Preventive IPM tools and tactics for each crop-pest combination should be used before and combined with the use of synthetic pesticides.
- Produce and update Crop and Pest Management Plans (CMP/PMP) with preventive tools and tactics as well as pesticides for all/each coffee-pest combination. Annex 1 of this PERSUAP provides IPM information, including the EILs, for most crop-pest combinations.

3.4 Factor D: Proposed Method or Methods of Application, Including the Availability of Application and Safety Equipment

Most smallholder coffee farmers use hand-pumped knapsack or backpack sprayers with hollow-cone nozzles to apply fungicides to plants and fan nozzles to apply herbicides to soil. Motorized backpack sprayers are used less commonly (due to high purchase and operating costs). On very large plantations conventional tractor raised boom sprayers, and on rare occasion tunnel sprayers, may also be used.

Issue: Backpack Sprayers Leak

Hand-pump backpack sprayers used by most smallholder coffee producers can and do eventually develop leaks at almost every junction (filler cap, pump handle entry, exit hose attachment, lance attachment to the hose and at the lance handle) and these leaks soak into exposed skin. Clothing serves to wick and hold these pesticides in contact with skin, and to concentrate them use after use, until washed.

Issue: Personal Protection Equipment Not Owned or Used

Most smallholder coffee farmers do not own or use PPE to apply pesticides to coffee plants or soil, and do not calibrate their sprayers properly, leading to over- and under-dosing. Most pesticide bottles will indicate precisely the type of PPE recommended for use of that specific pesticide. Applicators need to be trained to always read the label. If farmers are illiterate, they will need training to be able to read safety and PPE pictograms on pesticide labels. Typical PPE would first include the use of gloves for pouring and mixing the concentrated pesticide from the manufacturer's bottle to a bucket or sprayer.

Next, facemasks should be used to cover and protect the mouth and nose from pesticide mist inhalation. Goggles are recommended especially for the safe use of chemicals that are irritating or damaging to the eyes. Applicators should use daily-cleaned overalls, a rubber bib or a Tyvec® outfit to protect the body from pesticide mist exposure. Lastly, farmers should use rubber boots to protect feet from pesticide-sprayed vegetation.

Safe Pesticide Use (SPU)

²⁷ Personal communication from 2014 meetings with Colombia's FEDECAFE

Beyond IPM and GAPs, and in order to safely use the above-approved pesticides, this document provides brief guidelines and references to more detailed guidelines on basic SPU, including safe labeling, transport, storage, use, first aid and disposal, as well as associated training to reinforce these principles. USAID-funded projects and/or their sub-grantees and partners that support pesticide use (including but not limited to: purchase, finance through credit or voucher schemes, promote during training, or use on demonstration trials) are obligated to provide such safety training and periodic refresher training.

PERSUAP users should access all of these resources for SPU:

- EPA's Worker Protection Safety (WPS)²⁸ program
- EPA's Using Pesticides Safely²⁹ program,
- EPA's Human Health Issues³⁰ website and Emergency Information³¹ website
- EPA's website on Personal Protection Equipment³² provides guidance on safety equipment needed for pesticide use.
- United Nations (UN) Food and Agriculture Organization (FAO) provides Guidelines for Good Practice for Ground Application of Pesticides³³
- World Health Organization's SPU resources³⁴.

Issue: Empty Pesticide Container Disposal

The study found that many smallholder farmers throw empty pesticide containers in the field, which is not a recommended best practice. The empty containers need to be rinsed, punctured and buried, or use established recycling program (pesticide companies in Guatemala have done this through Crop Life International, and one of the consulting firms working in El Salvador has developed such a program as well).

Recommendations

- Mandatory training of farmers on proper use of PPE and frequent PPE washing, as well as sprayer calibration, use, maintenance and empty container disposal by rinsing, puncturing and burial.
- Promote the use of spray services that have trained application personnel that know how to properly calibrate sprayers, use quality pesticides, maintain sprayers, own PPE, and possess the means for proper disposal of empty containers.

3.5 Factor E: Any Acute and Long-Term Toxicological Hazards, either Human or Environmental, Associated with the Proposed Use, and Measures Available to Minimize Such Hazards

The PERSUAP development team found no instances of acute farmer poisonings from the use of coffee fungicides or herbicides.

Copper-containing fungicides in high product and backpack concentrations can be toxic to humans if ingested or absorbed through the skin. The concentrations of copper compounds in the

²⁸ <http://www.epa.gov/pesticides/health/worker.htm>

²⁹ <http://www.epa.gov/pesticides/health/safely.htm>

³⁰ <http://www.epa.gov/pesticides/health/human.htm>

³¹ <http://www.epa.gov/pesticides/health/emergency.htm>

³² <http://www.epa.gov/oppfead1/safety/workers/protective-equipment.html>

³³ <http://www.fao.org/docrep/006/y2767e/y2767e00.htm>

³⁴ http://www.who.int/water_sanitation_health/resources/vector385to397.pdf

undiluted products proposed by this PERSUAP are adequately low, and become even lower once mixed with water in the backpack sprayer, following recommended dosages, thus reducing risks to the applicator.

Copper is an essential factor for plant and animal growth and metabolism, but overuse of copper compounds can lead to accumulation in soil organic matter to the point that the soil becomes toxic to microbes necessary for producing plant nutrients as well as to coffee and other plants. That is why each copper compound comes with recommended dosages per unit of land, and number of uses per season. These PERSUAP-proposed concentrations (also recommended by the coffee industry in target countries) and dosages help mitigate the issue of copper soil toxicity.

The use of herbicides like glyphosate, which is very widely used, especially on commercial plantations as well as on some medium and small-scale farms, can lead to over-loss of vegetation leading to erosion of valuable topsoil. Cultivated hillsides with sparse vegetation are susceptible to landslides particularly during extreme rainfall events. The risk of topsoil erosion due to glyphosate over-application is low as few smallholder farmers can afford to buy glyphosate. Farmers typically control invasive vegetation manually by chopping them with a machete.

Recommendations

- Train coffee farmers on how to read safety precautions and first aid measures on pesticide labels and encourage them to use PPE.
- The pesticide safe use training required by this PERSUAP should include basic first aid for pesticide overexposure, availability and use of antidotes, and training on following recommendations found on pesticide labels and MSDSs for commonly used pesticides.
- Encourage smallholder farmers to control weeds manually.

3.6 Factor F: Effectiveness of the Requested Pesticide for the Proposed Use Pesticide procedures

The majority of the pesticides sold in LAC countries are from major multinational as well as regional companies, which assures better quality control. A few pesticides contain generic versions of off-patent pesticide AIs, some of which are from Chinese companies and may be of lower quality and supplied without proper agrodealer technical support. Common persistent weeds have developed resistance to highly used glyphosate in the USA³⁵. Each of the chemicals accepted by the Factor A analysis was researched for effectiveness.

Each pesticide chosen for analysis was found, through conversations with farmers, extension officials, coffee technical organizations and coffee pest management websites, to be recommended as effective (otherwise they would not be recommended).

All recommended pesticides were researched for resistance issues to each pest, disease or weed, as found in LAC countries. Our analysis found no LAC country studies that definitively showed that resistance had developed for any of the above pest/pesticide combinations. In any case, at some point resistance could develop, and if it does, references to resistance management websites are provided below, and farmers should always be encouraged to rotate among pesticide chemical classes (see table in Annex 2, column 2) to avoid such resistance.

³⁵ <http://www.weedscience.org/summary/home.aspx>

Resistance management strategies for fungal pathogens and weeds, as well as for insects, all include rotating among classes of pesticides from spray to spray or season to season. Pesticides with the same modes of action have been assigned group numbers by their respective pesticide resistance action committees, Fungicide Resistance Action Committee (FRAC)³⁶, Herbicide Resistance Action Committee (HRAC)³⁷ and Insecticide Resistance Action Committee (IRAC)³⁸.

Recommendations

- Train and encourage farmers to value and buy higher quality products from name brand companies and that come with technical support.
- Train farmers on the ways to reduce the development of resistance, as follow:
 - Use IPM to minimize pesticide use
 - Avoid knapsack mixes
 - Avoid use of persistent chemicals
 - Use long-term pesticide rotations

3.7 Factor G: Compatibility of the Proposed Pesticide Use with Target and Non-Target Ecosystems

Since fungicides are designed to kill fungal organisms, risks to animals and animal-like organisms are reduced. Likewise, herbicides kill plants, so risks to animals are reduced. However, in sufficient quantities, these chemicals can harm non-target organisms like fish, birds, and honeybees. Herbicides may also contaminate soil and groundwater resources. The labels on each of these chemicals contain risk information, as well as risk mitigation measures. Farmers must be trained to read and follow these instructions and precautions.

Coffee growth requirements are listed in Section 2 of this PERSUAP. Arabica coffee is generally grown within higher elevation (800-2000 MSL) mountainous ecosystems. In Central America and northern Colombia, coffee is inter-planted mostly in small-scale (1-2 ha) polycultures with other crops and trees, lending diversity to the system. Throughout central and southern Colombia it is planted in large-scale low-diversity monocultures.

Arabica coffee is primarily grown in wetter highland areas where watersheds begin, with underground water, springs and small streams. These highland streams eventually meet to form rivers in lower lands. Overuse or unwise use of pesticides in the headwaters can end up accumulating as one moves down the watershed and end up polluting these watersheds in downstream areas.

None of the potential coffee fungicides researched for this study is a known water pollutant. That is, none of them are known to leach through soil to remain persistent long enough to pollute groundwater. Widely used copper has the *potential* to harm aquatic life, but it usually stays tightly bound to soil organic matter; that is, it has a higher chemical affinity to soil than to water in the soil. However, it and other chemicals may enter surface water on soil particles to which it has bound.

³⁶ <http://www.frac.info/>

³⁷ <http://www.hracglobal.com/>

³⁸ <http://www.irac-online.org/>

Pesticide applicators should set a buffer zone between the coffee planting—where spraying will occur—and streams, rivers, or lakes as well as point sources of water. This buffer protects the water from spray drift and runoff. In general, a buffer of 30 meters should be used.

Widely used azoles and triazoles have the *potential* to reach groundwater, but none are known to do so significantly or persistently. Instead, they bind long enough to the soil to break down before reaching underground water, and/or break down once they reach groundwater.

Glyphosate, the cheapest and most widely used herbicide on coffee farms, is not a known groundwater pollutant. One of the researched coffee herbicide AIs are known groundwater pollutants: Diuron, which is rejected for use with USAID funds because it is also a known carcinogen.

Recommendations

- Train farmers about ecotoxicity and on how to read ecotoxicity precautions on pesticide labels.
- Train farmers on setting a buffer zone and applying pesticides the proper distance (30 meters) from open bodies of fresh water, as well as not to wash their sprayers out in springs, streams, rivers, ponds, lakes, or wetlands, or where rinse water may run off into these aquatic resources.
- All USAID funded projects using pesticides shall have a mixing and washing station equipped with shower, raised mixing platform, well drained basin filled with carbon and/or compost to capture and hold pesticides, under the mixing station.
- If needed, minimize chemical spray drift by using lower-pressure sprays and nozzles that produce larger droplets, as well as properly calibrating and maintaining spray equipment.
- Warn beekeepers of upcoming spray events so that they may move or protect their hives.
- Train farmers not to spray when honeybees are active and foraging.

3.8 Factor H: Conditions under which the Pesticide is to be used, including Climate, Flora, Fauna, Geography, Hydrology, and Soils

This Coffee Rust Programmatic PERSUAP is limited in length in order to be management-friendly, and thus does not have adequate space to include climate, flora, fauna, geography, hydrology, and soils information for each LAC target country. Most of the PERSUAPs already produced for LAC countries contain this basic information—refer to these for details.

In general, Arabica coffee in LAC countries is grown in tropical highlands, where temperatures are moderately cool and ideal for coffee (15-24 degrees C). Rainfall averages 1500 to 2000 mm per year and soils are predominantly sandy-loam. Most of these tropical highland soils provide good drainage; have a slightly acidic pH as well as a fairly balanced content of potassium, magnesium, calcium and phosphorus. The source of most tropical watersheds begins with streams and springs in the highlands; thus protection of these resources from overuse of fertilizers and pesticides is critical.

Flora and fauna include pine, hardwoods, fruit tree and eucalyptus forests with highland animals deer, fox, opossum, raccoon, rodents, tepesquintle, eagles, hawks, vultures, migratory and local songbirds as well as anoles, tree frogs and salamanders. Streams contain many species of aquatic insects, frogs, minnows and planktons. All of these are sensitive to pesticides and must be protected.

Issue: Pesticides can adsorb (stick) to soil, as well as leach and contaminate groundwater resources.

Each pesticide has physical and chemical characteristics, such as solubility in water, ability to bind to soil particles and be held there (adsorbed), and a natural breakdown or decomposition rate. If they are strongly held by soil they do not enter the soil water layers and the ground water table as easily. A listing of these properties for at least some of the pesticides in use in LAC countries can be found by checking this website: <http://sitem.herts.ac.uk/aeru/footprint/>.

In general, pesticides with water solubility greater than 3 mg/liter have the *potential* to contaminate groundwater; and pesticides with a soil adsorption coefficient of less than 1,900 have the *potential* to contaminate groundwater. In addition, pesticides with an aerobic soil half-life greater than 690 days or an anaerobic soil half-life greater than 9 days have the *potential* to contaminate groundwater. Moreover, pesticides with a hydrolysis half-life greater than 14 days have *potential* to contaminate groundwater.

The potential for pesticides to enter groundwater resources depends, as indicated above, on the electrical charge contained on a pesticide molecule and its ability and propensity to adhere to soil particles, but this also depends on the nature and charge of the soil particles dominant in the agriculture production area. Sand, clay and organic matter, and different combinations of all of these, have different charges and adhesion potential for organic and inorganic molecules. Sandy soil often has less charge capacity than clay or organic matter, and will thus not interact significantly with and hold charged pesticide molecules. So, in areas with sandy soil, the leaching potential for pesticides is increased, as is the velocity with which water and the pesticide migrate.

A pesticide's ability to enter groundwater resources also depends on how quickly and by what means it is broken down and the distance (and thus time) it has to travel to reach the groundwater. If the groundwater table is high, the risk that the pesticide will reach into it before being broken down is increased. Thus, a sandy soil with a high water table (less than 10 meters) is the most risky situation for groundwater contamination by pesticides. Groundwater pollution (contamination) potential for each pesticide active ingredient available in LAC countries is provided in Annex 7.

Since the risks for contamination of scarce water resources is high in most LAC countries, USAID-supported projects and sub-grantees should investigate these factors of soil adsorption and solubility before choosing pesticides to promote or support for their beneficiaries.

Recommendations

- Hydrology: Do not spray or rinse pesticide equipment in or within 30 meters of rivers, ponds, irrigation and drainage ditches, and other surface waters, including wetlands.
- Aquatic Life: Do not spray pesticides with high toxicities to aquatic organisms before an impending rainstorm, as they can be washed into waterways before breaking down.
- Soils: Do not use or recommend for use coffee herbicides near drinking water sources, on highly sandy soils or soils with water tables close (2-3 meters) to the surface.
- Soils: Since transport of soil particles with pesticides adsorbed to them is a potential transportation route to waterways, employ techniques to reduce coffee farm soil erosion whenever erosion is likely. Such techniques include the use of vegetated buffer strips, green manure, compost, mulching, terracing, employing windbreaks, employing

- nitrogen-fixing ground covers between rows, and planting coffee rows perpendicular to the slope.
- Promote pesticides that have lower potential for leaching and ground water contamination (see Annex 2, column 8 for any desired pesticide AI).

3.9 Factor I: Availability of Other Pesticides or Non-Chemical Control Methods

Several LAC countries have laboratories to produce tiny wasps as well as *Beauveria bassiana* that help control coffee berry borer. Many fungi and bacteria have the potential to act as biological control agents against rust. Species of both *Pseudomonas* and *Bacillus* are effective biocontrol agents of several types of crop rusts, including coffee rust under controlled conditions.

The indigenous strains of *Bacillus subtilis* and *Pseudomonas fluorescens* appear to function as better antagonists in disease control because they are well adapted to local conditions. However, rust has two fungal parasites, *Verticillium haemiliae* and *Verticillium psalliotae*³⁹, and these may be investigated for potential use in the field. Although there are possible natural controls including microbial rust antagonists in the research pipeline, none are available or commercially viable yet.

Otherwise, there are numerous preventive non-chemical practices known to increase the strength or vigor of coffee plants which helps reduce rust infection severity. They include the following:

- Plantation/Farm Renovation
- Resistant varieties
- Removing consistently heavily infested plants and replanting
- Quality/certified seed/seedling multiplication
- Weed control
- Pruning
- Cutting
- Use of fertilizers
- Control of abandoned farms
- Sanitation
- Topsoil conservation

Recommendation

- Promote use of preventive IPM tools and tactics for each crop-pest combination (Annex 1) before the choice is made to purchase and use synthetic pesticides.

3.10 Factor J: Host Country's Ability to Regulate or Control the Distribution, Storage, Use, and Disposal of the Requested Pesticide

The ability of LAC countries to regulate or control the distribution, storage, use and disposal of coffee pesticides depends upon staffing and resources for enforcement and extension. Often these are insufficient for the tasks at hand which is why donor projects fill in the gap, with technical and financial resources. However, in order to better understand the abilities in each country, refer to existing PERSUAPs for each at website <http://gemini.info.usaid.gov/egat/envcomp/search.php>.

³⁹ Waller, J.M., Bigger, M., Hillocks, R.J. (2007). Coffee pests, diseases and their management. Wallingford, Oxfordshire: CABI. 171. ISBN1-84593-129-7

Furthermore, market demand for “socially and environmentally responsible” coffee is driving the adoption of best practices on some larger commercial farms as well as on some boutique farms using best practices to capture certified markets. All coffee certification programs promote the use of sector best practices for the types, storage, use and disposal of coffee pesticides.

Recommendations

- Absolutely no Prior Informed Consent (PIC, <http://www.pic.int>) or Persistent Organic Pollutant (POP, <http://www.pops.int>) chemicals will be used or supported on USAID projects.
- Promote the voluntary adoption of coffee certification programs for coffee cooperatives and associations, where smallholder farmers are clustered together to share certification and other costs. These can be an effective way of promoting and monitoring safe and effective use of pesticides. Independent of factors like certification cost and levels of farmer organization, certification schemes and the oversight that comes with them can help coffee farmers access the necessary technical training to know how to use pesticides safely and efficiently.
- USAID projects should have on hand pesticide label and MSDS information for more popular fungicides and herbicides that their beneficiaries use.
- If a national or regional pesticide container recycling facility is available, USAID and project IPs should encourage its use.
- Train and encourage farmers to purchase inputs from suppliers that provide quality technical backup support, and to purchase and use PPE, or contract private pesticide spray services.

3.11 Factor K: Provision for Training of Users and Applicators

Each coffee producing country has national, private sector and donor programs for training and assisting smallholder farmers, but these programs do not have sufficient resources to reach all of them. This is where donors usually come in with additional resources. Many smallholder farmers know which pesticides to use for rust, but do not know how to properly calibrate sprayers and keep farm records

Smallholder farmers—in exchange for receiving cash and technical assistance—must begin to renovate their farms, by pulling out and replacing old plants with new vigorous and resistant varieties. Assistance should be conditional such that farmers should not be provided with inputs unless they agree to, and conduct, weeding and pruning. Otherwise farmers will continue to grow traditional old weak plants, that are not pruned or weeded, which will continually be attacked by diseases like rust. Once the farmers begin to renovate their farms, using coffee GAPs and IPM, losses to pathogens like rust should decrease.

Recommendations

- Farmers require training and refresher training on how to choose the correct pesticide, conduct knapsack sprayer calibration and record keeping, and implement proper pest identification and preventive IPM practices.

3.12 Factor L: Provision Made for Monitoring the Use and Effectiveness of the Pesticide

Most smallholder farmers do not keep farm records on pests prevented and controlled, chemicals and dosages used, and the effectiveness of each chemical application. If they complain that a certain chemical did not work properly, they may blame the product as being poor in quality, when in fact they may not have chosen the best chemical, miscalculated the correct dosage, misapplied the chemical, or not rotated among chemical classes often enough. USAID projects can assist with this need.

Recommendations

- The national coffee organizations in each country have forms for proper farm record keeping. Ensure that farmers use these.
- Encourage and train farmers in the use of farm or crop journals to keep track of their management of coffee and learn from their experiences.
- Each USAID project that works in the coffee value chain should have:
 - Copies of country laws related to the use of agrochemicals for plant protection, short notes on the relevance of the law, dates the laws come into or exit force and MRLs for each crop-pesticide combination.
 - A nationally registered pesticide checklist: This list allows project agronomists to ensure that the pesticides they are promoting, providing or using are registered locally. It should also provide notes on special safety requirements.
 - PPE: Lists of the types of equipment made available to applicators, number of pieces, prices and contact details of suppliers, dates when equipment needs to be washed, maintained or replaced. PPE should be numbered or personally assigned to applicators to ensure that it is not taken into the home where (as a contaminated material) it could pose a risk to family members.
- Monitoring/recording pests: Agronomists should incorporate into their records regular field pest monitoring and identification. This could be done by the USAID agriculture sector and value chain project agronomists themselves, or if properly trained, by farmers.
- Environmental conditions: Field conditions should be incorporated into the record keeping system (for example; precipitation, soil analyses and moisture, soil pH, temperatures and so on).
- Information should be transmitted at least annually and projects should report to USAID on this progress in pesticide safety and GAP/IPM use in annual reports.

SECTION 4: PESTICIDE SAFE USE ACTION PLAN (SUAP)

4.1 Introduction to the SUAP

This Safe Use Action Plan is the definitive statement of USAID LAC coffee value chain projects pesticide compliance requirements and is synthesized from the PER analysis:

- The Executive Summary enumerates allowed, conditional and rejected pesticides.
- Section 4.2 establishes USAID field monitoring requirements for compliance with safe use conditions
- Section 4.3 summarizes the recommended best practices and safe use conditions to be used/supported with these pesticides.

Each USAID LAC coffee value chain project will be required to insert into an Environmental Mitigation and Monitoring Plan (EMMP) each foreseeable risk, mitigation measure, indicator of mitigation success, monitoring timetable and responsible people/groups for implementation of these requirements, and for tracking compliance.

4.2 USAID field monitoring requirement

In addition to continuous monitoring by USAID/LAC coffee value chain projects and their sub-grantees environmental compliance staff and others delegated, USAID's AOR, MEO and/or REA must at least two times annually, make inspection visits to several randomly selected farms receiving project assistance to check for compliance with the IPM and safe use measures summarized in Section 4.3 below. Projects will also be required to fill (with recommendations from each Factor analysis, above) and use an EMMP compliance tracking and reporting template (see Annex 4 for an example).

4.3 Compliance Requirements (Safe Use Measures)

The allowed pesticide AIs listed in the Executive Summary can only be used in compliance with the safe use measures and restrictions specified in the PER. These are summarized as follows:

- Only pesticides approved by this PERSUAP may be supported with USAID funds. These pesticides are listed, with conditions, in color-coded matrices in the Executive Summary.
- Pesticide “support” = any of the following: use of USAID funds to: purchase pesticides; directly fund the application of pesticides; recommend pesticides for use; facilitate or enable the application or purchase of pesticides via provision of application equipment, credit support, or other means by the PI, their sub-grantees and partners.
- If pesticide use is supported, appropriate project staff, sub-grantees & beneficiaries must be trained in IPM (Annex 1), safe pesticide use & pesticide first aid;
- To the greatest degree practicable, if pesticide use is supported by USAID projects or their sub-grantees the IP must require that the beneficiary farmer use and maintain appropriate PPE—as well as implement safe pesticide purchase, handling, storage and disposal practices.

Annex 1: Matrix of Coffee Production Disease and Pest Constraints (in Addition to Rust) across the LAC Region, with Preventive Integrated Pest Management (IPM) Tools/Tactics

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
<p>Coffee leaf rust (la roya)</p> <ul style="list-style-type: none"> <i>Hemileia vastatrix</i> 	<ul style="list-style-type: none"> • Increase shade of coffee plants (plant trees) to increase biodiversity; this promotes growth of <i>Verticillium/Lecanicillium lecanii</i> “white halo” fungus and other species that attack and control rust. • Use certified varietal and disease-free planting material. • Do crop and plant monitoring to quickly locate and deal with disease symptoms. • Plant new certified varieties (like Catimor, Sarchimor) with resistance to coffee leaf rust. • Do hand weeding/chopping of weeds, especially with new young plantings. • Conduct proper pruning of coffee plants to reduce woody growth and strengthen the overall plant. • Cut or renovate old plantations (i.e., with plants older than 30 years) with new and/or resistant seedlings. • Manage soil and plant fertility for coffee by conducting soil and leaf analyses to determine macro and micronutrient requirements, and fertilize accordingly. • Use organic mulching to cover soil and help decompose dropped leaves. • Control abandoned coffee farms that serve as a source of rust inoculum for all plantations around them. 	<p>Since preventive sprays with copper compounds are recommended following rain and before symptoms appear, no universally applicable EILs have been set.</p>	<ul style="list-style-type: none"> • Implement preventive chemical control by using copper-containing fungicides like Bordeaux mixture, copper hydroxide, cuprous oxide, copper oxychloride or tribasic copper sulfate. • Implement preventive chemical control by using fungicides containing ferbam, mancozeb, maneb or ziram. • Implement curative chemical control by using fungicides containing any of the following active ingredients: azoxystrobin, captan, cyproconazole, flutriafol, fosetyl aluminum, myclobutanil, oxycarboxyn, propiconazole, pyraclostrobin, tebuconazole, triadimefon, triadimenol or trifloxystrobin.
Coffee berry borer (CBB,	<ul style="list-style-type: none"> • Use homemade pheromone & alcohol traps, and remove 	Begin sampling and	<ul style="list-style-type: none"> • Use sprays of the fungus

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
la broca) <ul style="list-style-type: none"> <i>Hypothenemus hampei</i>, Also named: <i>Hypothenemus coffeae</i>, <i>Xyleborus coffeivorus</i>, and <i>Xyleborus coffeicola</i> 	130 days after blooming. <ul style="list-style-type: none"> Prune, de-sucker and manage canopy to aerate and expose to sun. Pick berries at least fortnightly during fruiting peaks and at least monthly during other times. Do crop and plant monitoring to quickly locate and deal with insect infestation. Sanitation – make sure there are no unpicked infested beans left on the trees or laying on the ground. Burn, bury 18 inches deep, or boil & compost infested cherry. Use of hyperparasitic wasps, if made available, affordable and practical (especially on organic farms). Use coffee berry bags made from synthetic fiber instead of burlap. Tie bags shut at harvest to avoid the escape and dispersal of CBB. Carry bags to the wet mill as soon as possible. Set up baited traps in the wet mill area and at the end of the drying deck. Put mesh over wet mill drainage to capture CBB adults emerging from the fruits. Cover open ends of drying decks with permanent plastic roofs with fine mesh or sticky material to prevent the escape of CBBs. Control abandoned coffee farms that serve as a source of CBB infestation for all plantations around them. 	monitoring about 60–90 days after the first flowering. Sampling: Within a given hectare, from 30 trees, randomly select a productive branch containing 30 to 100 coffee berries and then count total number of berries in the branch and total number of berries infested by the CBB. The infestation level is the result of dividing the total number of infested berries over the total counted coffee berries. The sampling should be done in a monthly basis. Infestation levels cannot surpass 2% (EIL) for smaller farms; CENICAFE has chosen a 5% EIL for larger farms.	<i>Beauveria bassiana</i> , if made available, affordable and practical (especially on organic farms). <ul style="list-style-type: none"> Do not support use of commonly desired endosulfan (banned internationally), carbosulfan (not EPA registered), chlorpyrifos (no longer registered for agriculture) or fenitrothion (not registered for agriculture).
Coffee leaf miners	<ul style="list-style-type: none"> Do crop and plant monitoring to quickly locate and deal 	No EILs have been	<ul style="list-style-type: none"> Can try insecticides

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
<ul style="list-style-type: none"> • <i>Leucoptera meyricki</i>, • <i>Perileucoptera coffeella</i> and • <i>Leucoptera coffeina</i> 	<ul style="list-style-type: none"> with insect infestation. • Use resistant varieties. • Use of natural enemies, especially parasitic wasps in the genus <i>Diglyphus</i>, can be effective in reducing populations of leafminers. • Intercrop coffee with <i>Artemisia</i> and do not plant spinach next to the plantation. • Monitor crops. It is important that farmers inspect the entire area to locate the presence and number of pests. • Use pheromone traps outside of the orchard to pull moths away from coffee. 	developed yet. At 4 mines per leaf, the leaves will shed/fall.	<ul style="list-style-type: none"> containing granular formulations of thiamethoxam. • Can try insecticides containing cyromazine.
<p>Coffee Stem Boring Beetles:</p> <ul style="list-style-type: none"> • Black borer (<i>Apate monachus</i>) • Twig borer (<i>Xylosandrus compactus</i>) • White Stem Borer (<i>Monochamus leuconotus</i>) 	<ul style="list-style-type: none"> • Increase shade of coffee plants (plant trees), as a means to reduce stem borer damage relative to plants grown in full sun. • Do continuous monitoring to find infested stems. • Find entry holes and push a flexible wire into them to kill the larvae. • Pruning: cut off and destroy (burn) infested stems and heavily infested plants. • Use traps for female beetles. • Do not plant trees with twisted taproots. These deformed roots result in weak trees that have been shown to have a high incidence of stem borer infestation. • There is not a known biological control at this time (FAO). 	No EILs exist.	<ul style="list-style-type: none"> • No effective chemical controls are known (FAO). • (Do not support use of commonly desired endosulfan (banned internationally), aldicarb (RUP), carbofuran (RUP), chlorpyrifos (not registered for agriculture) or diazinon (not registered for agriculture)).
<p>Coffee leaf and stem aphids:</p> <ul style="list-style-type: none"> • Black citrus aphid (<i>Toxoptera aurantii</i>) and others, exude honeydew onto leaves and twigs; black sooty mold then grows on this honeydew exudate, blocking 	<ul style="list-style-type: none"> • Damage is generally more severe on seedlings and younger plants; older plants recover from aphid feeding damage. • Do crop and plant monitoring to quickly locate and deal with insect infestation. • Aphids are tended and protected by ants. Try to manage or control ants in the plantation. • Do pruning to open canopy to light, predators and parasites. • There are a number of natural predators of coffee scale such as wasps, ladybugs and <i>Verticillium/Lecanicillium lecanii</i> “white halo” fungus. In many instances, these will reduce the level of scale infestation. Rely upon these 	Control is generally not warranted. No EILs exist.	<ul style="list-style-type: none"> • If available, can use natural potassium salts of fatty acids (insecticidal soaps). • Spray infested plants with an insecticide containing neem oil or mineral oil. • Can try natural chili pepper extracts (capsaicinoids). • Can try insecticides

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
photosynthesis	<p>natural enemies.</p> <ul style="list-style-type: none"> Do soil tests and manage soil and plant fertility well. Use care with nitrogen-containing fertilizers that can spur new vegetative growth favorable to aphids. 		containing granular formulations of thiamethoxam or imidacloprid.
<p>Coffee mealy bugs:</p> <ul style="list-style-type: none"> Citrus mealy bug (<i>Planococcus citri</i>) Coffee mealy bug (<i>Planococcus lilacinus</i>) Passionvine mealy bug (<i>Planococcus minor</i>) Striped mealy bug (<i>Ferrisia virgata</i>) 	<ul style="list-style-type: none"> Exude honeydew onto leaves and twigs; black sooty mold then grows on this honeydew exudate, blocking photosynthesis Mealy bugs are tended and protected by ants. Try to manage or control ants in the plantation. Conduct crop and plant monitoring to quickly locate and deal with insect infestation. Prune plants to open canopy to light, predators and parasites. There are a number of natural predators of coffee mealy bugs such as wasps, ladybugs and fungi. In many instances, these will reduce the level of mealy bug infestation. Rely upon these natural enemies. Use care with nitrogen-containing fertilizers that can spur new vegetative growth favorable to mealy bugs. 	No EILs exist.	<ul style="list-style-type: none"> If available, can use natural potassium salts of fatty acids (insecticidal soaps). Spray infested stems with an insecticide containing malathion. Can try insecticides containing granular formulations of thiamethoxam or imidacloprid.
<p>Coffee scales:</p> <ul style="list-style-type: none"> Soft green scale (<i>Coccus viridis</i>) Citrus mealybug (<i>Planococcus citri</i>) Hemispherical scale (<i>Saissetia coffeae</i>) White wax scale (<i>Ceroplastes destructor/brevicauda</i>) exude honeydew onto leaves and twigs; black sooty mold then grows on this honeydew 	<ul style="list-style-type: none"> Scales are tended and protected by ants. Try to manage or control ants in the plantation. Do crop and plant monitoring to quickly locate and deal with insect infestation. Do pruning to open canopy to light, predators and parasites. Do weeding in and around plantation. There are a number of natural predators of coffee scale such as wasps, ladybugs and <i>Verticillium/Lecanicillium lecanii</i> “white halo” fungus. In many instances, these will reduce the level of scale infestation. Rely upon these natural enemies. Use care with nitrogen-containing fertilizers that can spur new vegetative growth favorable to scales. 	Only spray if ten or more leaves are infested with one or more scales (FAO reference EIL).	<ul style="list-style-type: none"> Natural agricultural mineral oil sprays may be used Spray infested stems with an insecticide containing carbaryl, dimethoate or malathion. Can try insecticides containing granular formulations of thiamethoxam.

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
exudate, blocking photosynthesis			
<p>Coffee mites:</p> <ul style="list-style-type: none"> Coffee Red Mite (<i>Oligonychus coffeae</i>) Southern Red Mite (<i>Oligonychus ilicis</i>) Red Flat Mite (<i>Brevipalpus phoenicis</i>) that can transmit coffee ringspot virus (CRV) causing leaf fall and off-flavor coffee 	<ul style="list-style-type: none"> Drought favors mites. Keep plants well watered during dry periods. Prune to open canopy to light, predators and parasites. Weed in and around plantation. Reduce dust in plantation by driving slowly on dirt roads. Conduct crop and plant monitoring to quickly locate and deal with mite infestation. Increase shade of coffee plants (plant trees) to increase biodiversity, which leads to the growth of <i>Verticillium/Lecanicillium lecanii</i> “white halo” fungus and other species that attack and control mites. Conduct soil tests, and manage soil and plant fertility well. 	<p>Most mites are visible only under a hand-lens, which smallholder farmers do not have. Mites are not easily or practically sampled and monitored by farmers. No EILs exist.</p>	<ul style="list-style-type: none"> Spray infested stems with an insecticide containing neem oil or mineral oil.
<p>Root knot nematodes</p> <ul style="list-style-type: none"> <i>Meloidogyne</i> species 	<ul style="list-style-type: none"> Use resistant cultivars and grow healthy plants; use appropriate spacing, weeding, fertilizer and water management). Conduct crop and plant monitoring to quickly locate and deal with nematode infestation. Prune coffee and manage shade trees to improve plant vigor. Sanitation: Remove and destroy heavily infested plants and compost crop debris. Use organic fertilizer, particularly chicken manure and composts, to add organic matter and soil structure, especially to sandy soils. Weed to ensure that soil nutrients go to and strengthen coffee rather than weeds. Inter-plant with flax to reduce root knot nematode levels. Inter-plant with Marigold (<i>Tagetes minuta</i> and <i>Tagetes patula</i>, respectively). After 2 months of Marigold growth, cut and introduce the flower to the soil. 	<p>Nematodes are not visible to the naked eye and are not easily or practically sampled and monitored by farmers. No EILs exist, although a Hawaii coffee workshop (see reference in Annex 3) notes that EIL is any nematode presence, with presence indicating that measures must to be taken.</p>	<ul style="list-style-type: none"> Management of nematodes is difficult, especially in sandy soils, and most nematicides are Class I, which USAID projects should not support. Botanical and homemade water extracts of basil, garlic, neem seed and <i>Tagetes erecta</i> extract (if available artisanally or commercially—and affordable) may be effective controls. If available and affordable, sprays of biological control <i>Paecilomyces lilacinus</i> or <i>Bacillus firmus</i> might be used.

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
			<ul style="list-style-type: none"> • Can try natural allyl isothiocyanate (mustard oil extract) or capsaicinoids (chili pepper extracts). • Two new commercialized products, if registered, available and affordable, can be used as effective nematode controls: the microbe <i>Myrothecium verrucaria</i> and a natural soil biopesticide containing extracts of tomatillo oil and thyme oil and labeled as Promax (http://humagroturf.com/tag/organic-nematicide/).
<p>Coffee berry disease</p> <ul style="list-style-type: none"> • <i>Colletotrichum kahawae/coffeanum</i> 	<ul style="list-style-type: none"> • Plant certified disease-free seedlings of resistant varieties where coffee berry disease is endemic. • Prune coffee bushes to open the canopy to air movement and light, which reduce disease incidence. • Make and use compost to add organic matter to the soil. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Weed by chopping or mower. • Fertilize properly to maintain plant vigor. • Prune coffee trees after harvest. • Sanitation: Strip off diseased berries and leaves. Remove old stems and thin out branches. • Sanitation: Pull out and destroy plants that are consistently heavily infected. • Regularly clean farm tools and pruning shears between plants and plantations. 	<p>Since preventive sprays with copper compounds are recommended following rain and before symptoms appear, no EILs have been set (Hawaii coffee workshop, see reference in Annex 3).</p>	<ul style="list-style-type: none"> • Natural oils, like neem seed and mineral may provide some preventive control. • Spray natural compounds containing copper and/or sulfur/lime sulfur and sodium bicarbonates. • If it becomes commercially available and affordable, sprays of the bacterial biological control agent <i>Pseudomonas fluorescens</i> may be used. • Can use fungicides

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
			containing azoxystrobin, thiophanate-methyl, propiconazole, thiram or pyraclostrobin.
Anthracnosis <ul style="list-style-type: none"> <i>Colletotrichum gloeosporioides</i> 	<ul style="list-style-type: none"> Plant certified disease-free seedlings where Anthracnosis disease is endemic. Prune coffee bushes to open up the canopy to air movement and drying after rain and during periods of wet, foggy weather. Do crop and plant monitoring to quickly locate and deal with disease symptoms. Sanitation: Hand prune diseased leaves and twigs off of the plant Pull out and destroy consistently heavily infected plants that serve as a source of inoculum for the rest of the plantation. Make and use compost to add organic matter to the soil. Fertilize properly to maintain plant vigor. Weed by chopping or mower. Regularly clean farm tools and pruning shears between plants and plantations. 	Since preventive sprays with copper compounds are recommended following rain and before symptoms appear, no EILs have been set (Hawaii coffee workshop, see reference in Annex 3).	<ul style="list-style-type: none"> Natural oils, like neem seed and mineral oils may provide some preventive control. Spray natural compounds containing copper and/or sulfur/lime sulfur and sodium bicarbonates. If coffee prices are sufficiently high to justify the costs, commercial producers often spray fungicides containing azoxystrobin, ferbam or cyproconazole. If it becomes commercially available and affordable, sprays of the bacterial biological control agent <i>Pseudomonas fluorescens</i> may be used.
Rooster's eye leaf spot <ul style="list-style-type: none"> <i>Mycena citricolor</i> 	<ul style="list-style-type: none"> Manage the canopy by pruning and opening the canopy to air and light. Do not plant more than 2,500 plants per Guatemalan manzana (0.7 ha), http://ces.iisc.ernet.in/energy/HC270799/HDL/spanish/p/r0054b/r0054b0n.htm . Remove and destroy or compost infected leaves. Sanitation: Remove and burn or compost old orchard 	Since preventive sprays with systemic compounds are recommended following rain and before symptoms appear, no EILs	<ul style="list-style-type: none"> Natural oils, like neem seed and mineral oils may provide some preventive control. Can spray Bordeaux mix. If available and affordable, use sprays of <i>Trichoderma harzianum</i>

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
	<p>coffee bushes that are infested, not maintained and no longer productive.</p> <ul style="list-style-type: none"> • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Maintain well-fertilized plants with 50% shade cover. • Shorten pruning cycles in presence of the disease to obtain good production. • Make and use compost to add organic matter to the soil. • Weed by chopping or mower. • Regularly clean farm tools and pruning shears between plants and plantations. 	<p>have been set. Apply a systemic fungicide no more than fifteen days following the start of rains, (Anacafe, see Annex 3, references)</p>	<p>to reduce this leaf spot.</p> <ul style="list-style-type: none"> • Can use fungicides containing cyproconazole, tebuconazole, triadimenol or thiabendazole.
<p>Cercospora brown leaf and fruit spot</p> <ul style="list-style-type: none"> • <i>Cercospora/ Mycosphaerlla coffeicola</i> 	<ul style="list-style-type: none"> • Increase shade of coffee plants (plant trees) to 50% to increase biodiversity, which leads to the growth of <i>Verticillium/Lecanicillium lecanii</i> “white halo” fungus and other species that control <i>Cercospora</i>. • Test soil and conduct leaf analyses to determine coffee fertility needs, especially lack of nitrogen and potassium; fertilize accordingly. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Weed mechanically to free up soil nutrients to strengthen coffee plants. • Prune coffee bushes to open the canopy to air movement and light, which reduce disease incidence. • In presence of the disease, the pruning cycles should be shortened to obtain good production. • Sanitation: remove and burn or compost old orchard coffee bushes that are infested, not maintained and no longer productive. 	<p>No EILs exist (Hawaii coffee workshop, see reference in Annex 3).</p>	<ul style="list-style-type: none"> • Natural oils, like neem seed and mineral may provide some preventive control. • If available and affordable, use sprays of <i>Trichoderma harzianum</i> to reduce this leaf spot. • Use sprays containing copper oxychloride, copper oxide, or tribasic copper sulfate. • Use sprays containing mancozeb, triadimenol, ferbam or folpet.
<p>Coffee leaf Phoma black spot</p> <ul style="list-style-type: none"> • <i>Phoma</i> species 	<ul style="list-style-type: none"> • Occurs post-blossom, before fruit ripening, where climatic conditions are cool, wet and windy. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Plant a windbreak on the predominant windward side of the plantation fields. 	<p>No EILs exist.</p>	<ul style="list-style-type: none"> • Fungicides used by farmers include the same as used for <i>Cercospora</i>. • Sprays of neem seed extracts and oils reduce <i>Phoma</i> incidence.

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
	<ul style="list-style-type: none"> • Make and use compost to add organic matter to the soil. • Fertilize properly to maintain plant vigor. • Weed by chopping or mower. • Regularly clean farm tools and pruning shears between plants and plantations. 		
Coffee Collar Rot <ul style="list-style-type: none"> • <i>Phytophthora</i> species 	<ul style="list-style-type: none"> • Conduct frequent crop monitoring for disease symptoms. • Make and use compost to add organic matter to the soil. • Fertilize properly to maintain plant vigor. • Weed by chopping or mower. • Regularly clean farm tools and pruning shears between plants and plantations. • Prune coffee bushes to open the canopy to air movement and light, which reduce disease incidence. • Sanitation: Pull out and destroy plants that are consistently heavily infected. 	No EILs exist.	<ul style="list-style-type: none"> • If available and affordable, can spray biological <i>Trichoderma harzianum</i>. • Can use fungicides containing thiophanate-methyl.
Coffee Limb Blight <ul style="list-style-type: none"> • <i>Corticium salmonicolor</i> 	<ul style="list-style-type: none"> • Avoid densely or closely spaced plantings, as the fungus thrives best under warm, moist conditions. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Maintain soil and plants in a healthy, vigorous state of growth. • Monitor for disease presence and incidence. • Prune out infected branches and heavily infected plants; these should be burned or completely eradicated to keep the source of infection at a minimum. • Improve soil drainage and crop aeration through pruning. 	No EILs exist.	<ul style="list-style-type: none"> • Can spray Bordeaux mix. • Can use fungicides containing copper oxychloride.
Coffee black rot <ul style="list-style-type: none"> • <i>Pellicularia koleroga</i> 	<ul style="list-style-type: none"> • Make and use compost to add organic matter to the soil. • Fertilize properly to maintain plant vigor. • Weed by chopping or mower. • Regularly clean farm tools and pruning shears between plants and plantations. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. 	No EILs exist.	<ul style="list-style-type: none"> • Can use fungicides containing cyproconazole, tebuconazole or triadimenol.

Primary Coffee Pests	PERSUAP Recommended Preventive Coffee GAP and IPM tools/tactics to integrate	Economic injury level (EIL), or action threshold, or treatment level	Pesticides to Integrate
	<ul style="list-style-type: none"> • Prune of coffee bushes to open the canopy to air movement and light, which reduce disease incidence. • Sanitation: Pull out and destroy plants that are consistently heavily infected. 		
<p>Pseudomonas bacterial rot</p> <ul style="list-style-type: none"> • <i>Pseudomonas syringae</i> 	<ul style="list-style-type: none"> • Make and use compost to add organic matter to the soil. • Conduct crop and plant monitoring to quickly locate and deal with disease symptoms. • Fertilize properly to maintain plant vigor. • Weed by chopping or mower. • Regularly clean farm tools and pruning shears between plants and plantations. • Prune of coffee bushes to open the canopy to air movement and light, which reduce disease incidence. • Sanitation: Pull out and destroy plants that are consistently heavily infected. 	No EILs exist	<ul style="list-style-type: none"> • Use bactericides containing copper. • Try <i>Pseudomonas fluorescens</i> as a bacterial antagonist.
<p>Weeds</p> <p>Various species</p>	<ul style="list-style-type: none"> • Chop weeds with machete, or cut with mower. • Conduct crop and plant monitoring to quickly locate and deal with weeds. • At end of the harvest, manually remove weeds two times a year. The first weed control should occur a month before the harvest; the second four months after the first pruning. • Apply organic mulches that smother weeds and augment the soil texture. 	No EILs exist (Hawaii coffee workshop, see reference in Annex 3).	<ul style="list-style-type: none"> • Can use herbicides containing 2,4-D, ametryne, clethodim, flazasulfuron, fluazifop-p-butyl, oryzalin, oxyfluorfen, pelargonic/nonanoic acid, sethoxydim or glyphosate (but this may lead to excessive loss of topsoil and landslides during heavy rain storms).

Annex 2: PERSUAP Analyses of Active Ingredients in Fungicides and Herbicides Used for Coffee

Introduction to Annex 2

Annex 2 compiles the AIs in pesticides (natural and synthetic) found to be used on coffee. Project decision-makers—especially those who interface at the field level with beneficiary farmers—are encouraged to: (1) look at the label of potential pesticide choices to determine the AIs contained in them; and, (2) use this annex as a quick reference guide to the attributes and issues of each chemical. **Where available, Class III and IV pesticides should be preferentially used in place of Class II pesticides.**

The pesticide attributes include class (to manage resistance by rotating chemicals from different classes), EPA registration, Restricted Use Pesticide (RUP) status (to comply with USAID Regulation 216), and acute toxicity (judged by this document to be safe, or not, for smallholder farmers—most Class I chemicals are not considered safe for smallholder farmers to use). Annex 2 also presents chronic health toxicity, water pollution potential, and potential toxicities to important non-target organisms such as fish, honeybee pollinators, birds and aquatic organisms. **Table headings show how each column addresses selected parts of the 12-factor analysis.** The introductory table lists the recommended pesticide for each coffee pest, disease and weed.

Further, Annex 2 contains basic human safety and environmental data for the various analyses required throughout the PER and is referred to throughout this document. This PERSUAP provides useful tools for evaluating and choosing among IPM options, including natural and synthetic pesticides, while adhering to 22 CFR 216.

Key to matrix:

Green shading: Can be supported on USAID-supported activities

RUP: Few = one or two products; Some = a third of products; Most/All = most or all products

WHO Acute Toxicity Classes: O = Obsolete; Ia = Extremely Hazardous; Ib = Highly Hazardous; II = Moderately Hazardous; III = Slightly Hazardous; U = Unlikely to present acute hazard in normal use

EPA Acute Toxicity Classes: I = Extremely Toxic; II = Highly Toxic; III = Moderately Toxic; IV = Slightly Toxic

Chronic Human Toxicity: KC = Known Carcinogen; PC = Possible Carcinogen; LC = Likely Carcinogen; ED = Potential Endocrine Disruptor; RD = Potential Reproductive & Development Toxin; P = Risk of Parkinson's

Ecotoxicity: NAT = Not Acutely Toxic; PNT = Practically Not Toxic; ST = Slightly Toxic; MT = Moderately Toxic; HT = Highly Toxic; VHT = Very Highly Toxic

Coffee Pest or Disease	Recommended Pesticides
Coffee leaf rust (CLR, la roya) <ul style="list-style-type: none"> <i>Hemileia vastatrix</i> 	<ul style="list-style-type: none"> Bordeaux mixture cuprous oxide copper oxychloride tribasic copper sulfate ferbam mancozeb maneb ziram azoxystrobin cyproconazole flutriafol fosetyl aluminum myclobutanil oxycarboxyn propiconazole pyraclostrobin tebuconazole triadimefon triadimenol trifloxystrobin
Coffee berry borer (CBB, la broca) <ul style="list-style-type: none"> <i>Hypothenemus hampei</i>, Also named: <i>Hypothenemus coffeae</i>, <i>Xyleborus coffeivorus</i>, and <i>Xyleborus coffeicola</i> 	<ul style="list-style-type: none"> <i>Beauveria bassiana</i>
Coffee leaf miners (CLM) <ul style="list-style-type: none"> <i>Leucoptera meyricki</i>, <i>Perileucoptera coffeella</i> and <i>Leucoptera coffeina</i> 	<ul style="list-style-type: none"> No pesticides can be recommended.
Coffee Stem Boring Beetles (SBB) <ul style="list-style-type: none"> Black borer (<i>Apate monachus</i>) Twig borer (<i>Xylosandrus</i>) 	<ul style="list-style-type: none"> No effective chemical controls are known.

<i>compactus</i>) • White Stem Borer <i>(Monochamus leuconotus)</i>	
Coffee leaf and stem aphids CLA • Black citrus aphid (<i>Toxoptera aurantii</i>) and others	• insecticidal soaps • neem oil • mineral oil • chili pepper extract • imidacloprid • thiamethoxam
Coffee mealy bugs (CMB) • Citrus mealy bug (<i>Planococcus citri</i>) • Coffee mealy bug (<i>Planococcus lilacinus</i>) • Passionvine mealy bug (<i>Planococcus minor</i>) • Striped mealy bug (<i>Ferrisia virgata</i>)	• insecticidal soaps • malathion • imidacloprid • thiamethoxam
Coffee scales (CS) • Soft green scale (<i>Coccus viridis</i>) • Citrus mealybug (<i>Planococcus citri</i>) • Hemispherical scale (<i>Saissetia coffeae</i>) • White wax scale (<i>Ceroplastes destructor/brevicauda</i>)	• mineral oil • carbaryl • dimethoate • malathion • thiamethoxam
Coffee mites (CM) • Coffee Red Mite (<i>Oligonychus coffeae</i>) • Southern Red Mite (<i>Oligonychus ilicis</i>) • Red Flat Mite (<i>Brevipalpus phoenicis</i>)	• neem oil • mineral oil
Root knot nematodes (RKN) • <i>Meloidogyne</i> species	• <i>Paecilomyces lilacinus</i> • <i>Bacillus firmus</i> • allyl isothiocyanate • capsaicinoids

	<ul style="list-style-type: none"> • <i>Myrothecium verrucaria</i> • extracts of tomatillo oil and thyme oil
Coffee berry disease (CBD) <ul style="list-style-type: none"> • <i>Colletotrichum kahawae/coffeanum</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • Bordeaux mixture • Sodium bicarbonate • cuprous oxide • copper oxychloride • tribasic copper sulfate • <i>Pseudomonas fluorescens</i> • azoxystrobin • thiophanate-methyl • propiconazole • thiram • pyraclostrobin
Coffee Anthracnosis (CA) <ul style="list-style-type: none"> • <i>Colletotrichum gloeosporioides</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • Bordeaux mixture • Sodium bicarbonate • cuprous oxide • copper oxychloride • tribasic copper sulfate • azoxystrobin • ferbam • cyproconazol • <i>Pseudomonas fluorescens</i>
Rooster's eye leaf spot (RES) <ul style="list-style-type: none"> • <i>Mycena citricolor</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • Bordeaux mix • <i>Trichoderma harzianum</i> • cyproconazole • tebuconazole • triadimenol • thiabendazole
Cercospora brown leaf and fruit spot (CLS) <ul style="list-style-type: none"> • <i>Cercospora/</i> 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • <i>Trichoderma harzianum</i>

<i>Mycosphaerlla coffeicola</i>	<ul style="list-style-type: none"> • copper oxychloride • copper oxide • tribasic copper sulfate • mancozeb • triadimenol • ferbam • folpet
Coffee leaf Phoma black spot (CPS) <ul style="list-style-type: none"> • <i>Phoma</i> species 	<ul style="list-style-type: none"> • neem seed oil • mineral oil • <i>Trichoderma harzianum</i> • copper oxychloride • copper oxide • tribasic copper sulfate • mancozeb • triadimenol • ferbam
Coffee Collar Rot (CCR) <ul style="list-style-type: none"> • <i>Phytophthora</i> species 	<ul style="list-style-type: none"> • <i>Trichoderma harzianum</i> • thiophanate-methyl
Coffee Limb Blight (CLB) <ul style="list-style-type: none"> • <i>Corticium salmonicolor</i> 	<ul style="list-style-type: none"> • Bordeaux mix • copper oxychloride
Coffee black rot (CBR) <ul style="list-style-type: none"> • <i>Pellicularia koleroga</i> 	<ul style="list-style-type: none"> • cyproconazole • tebuconazole • triadimenol
Pseudomonas bacterial rot (PBR) <ul style="list-style-type: none"> • <i>Pseudomonas syringae</i> 	<ul style="list-style-type: none"> • Bordeaux mixture • cuprous oxide • copper oxychloride • tribasic copper sulfate • <i>Pseudomonas fluorescens</i>
Weeds Impacting Coffee (WIC) Various species	<ul style="list-style-type: none"> • 2,4-D • ametryne • clethodim • flazasulfuron • fluazifop-p-butyl • fomesafen-sodium • oryzalin • oxyfluorfen • pelargonic/nonanoic acid

	<ul style="list-style-type: none">• sethoxydim• glyphosate
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Active Ingredients in Recommended Coffee Disease Fungicides & Bactericides (F&B)*

Pesticide Active Ingredients proposed for control of coffee diseases and thus proposed for Reg 216 analysis	Chemical Class. Reg 216, Factor I Availability of Other Pesticide Options: AI chemical classes for rotation to avoid development of resistance, and reduction of effectiveness (Factor F)	Reg 216, Factor A: Is Pesticide AI EPA Registered?	Reg 216, Factor A: Any Restricted Use Coffee Pesticides with this AI?	Reg 216 Factor E: WHO Acute Toxicity Class	Reg 216 Factor E: EPA Acute Toxicity Classes	Reg 216 Factor E: EPA Chronic Toxicity	Groundwater contaminant. Reg 216 Factors G & H (Non-target ecosystem, Hydrology)	Reg 216 Factors E & G: Ecotoxicity, Non-target Impacts									US EPA PC Code
								fish	bees	birds	amphibians	worms	Mollusks	Crustaceans	Aquatic Insects	Plankton	
azoxystrobin	strobin	yes	no	U	III	NL	potential	MT	MT	MT		MT		MT		VHT	128810
Bordeaux mixture components	inorganic (F & B)*	yes	no	III	NL	NL	no data	HT	MT	MT		MT		MT			008101
copper (cuprous) oxide	inorganic (F & B)	yes	no	II	II, III	NL	no data	HT					HT	HT		VHT	075601
captan	thiophthalamide	yes	no	NL	II, III	PC	no data	HT	NAT	PNT	MT		MT	NAT	MT	MT	081301
																	023401,
copper/cupric hydroxide	inorganic	yes	no	II	II, III	NL	no data	HT	MT	MT		MT	HT	NAT	HT	HT	823401
																	025601,
copper oxychloride	inorganic (F & B)	yes	no	NL	II, III	NL	no data	MT	MT	MT		MT				VHT	825601,
copper sulfate (tribasic)	inorganic (F & B)	yes	no	NL	II, III	NL	no data	ST			MT			ST		HT	023501
	botanical essential oil																
citrus extract oil	oil	yes	no	NL	III	NL	no data										008101
cyproconazole	azole	yes	no	III	III	PC	no data	MT	MT	MT		MT				MT	128993
ferbam	dithiocarbamate	yes	no	U	III	NL	no data	HT	MT	MT	MT	MT	HT		HT	HT	034801
horticultural oil	mineral oil	yes	no	NL	III	NL	no data	NAT									128940
flutriafol	triazole	yes	no	III	NL	ED	potential	MT	MT	LT		MT		MT			123301
folpet	thiophthalamide	yes	no	U	II, III	PC	no data	HT	PNT	ST	HT	MT	ST	HT		MT	014504
fosetyl aluminum	unclassified	yes	no	NL	II, III	NL	potential	NAT	ST	ST		MT		NAT		MT	014505
						PC, ED,											
mancozeb	dithiocarbamate	yes	no	U	III	RD	no data	MT	MT	ST	HT					NAT	063503
						PC, ED,											
maneb	dithiocarbamate	yes	no	U	III	RD	no data	MT	NAT	PNT	ST			ST		HT	025006,
mineral oil	petroleum/parafin	yes	no	NL	III	NL	no data	NAT									825006
				non													128857
neem oil	botanical	yes	no	e	III	none	no data	NAT					NAT		NAT		090202
						ED,											
myclobutanil	azole	yes	no	III	III	RD	no data	MT	ST	MT		MT		MT		HT	122101
oxycarboxin	carboxamide	yes	no	U	III	NL	no data	MT	NAT	MT	ST			MT			006438
						PC,											
propiconazole	azole	yes	no	II	II, III	RD	potential	MT					MT	ST	MT	MT	099100
<i>Pseudomonas fluorescens</i>	microbial	yes	no	NL	III	NL	no data										073506,
pyraclostrobin	strobin	yes	no	NL	II, III	NL	potential	ST	MT	MT		MT		HT			873506
																	077501

sodium bicarbonate	inorganic	yes	no	NL	III	NL	no data	NAT						NAT	NAT	128997
sulfur	inorganic	yes	no	U	III	NL PC, ED	no data	NAT	NAT	NAT	NAT				NAT	060101
tebuconazole	azole	yes	no	III	II, III	PC, PC, RD	potential	MT	MT	MT		MT	MT	MT	HT	102001
thiabendazole	azole	yes	no	U	III	PC, PC, RD	no data	ST	NAT		MT	ST			ST	079801
thiophanate methyl	benzamidazole	yes	no	U	III	ED, RD	potential	MT	PNT		NAT		ST			109901
thiram	(dithio) carbamate	yes	no	III	III	PC, ED, RD	no data	HT	NAT	PNT	VHT	HT	NAT	HT	HT	127201
triadimefon	triazole	yes	no	III	II, III	PC, PC, ED	potential	MT	MT	PNT		MT	NAT			128903
triadimenol	triazole	yes	no	III	II, III	ED	no data	MT	ST	MT		MT				129112
<i>Trichoderma harzianum</i>	microbial	yes	no	NL	III	NL	no data									034805,
trifloxystrobin	strobin	yes	no	NL	III	NL PC, ED,	no data	ST	ST	MT		MT				911188
ziram	dithiocarbamate	yes	no	III	III	RD, P	no data	HT	NAT	MT	HT	MT		HT		008101

*(F&B), all copper-containing compounds can be used against fungal and bacterial diseases

Active Ingredients in Accepted/Recommended Coffee Insecticides/Miticides

Pesticide Active Ingredients proposed for control of coffee insects, mites and thus proposed for Reg 216 analysis	Chemical Class. Reg 216, Factor I Availability of Other Pesticide Options: AI chemical classes for rotation to avoid development of resistance, and reduction of effectiveness (Factor F)	Reg 216, Factor A: Is Pesticide AI EPA Registered?	Reg 216, Factor A: Any Restricted Use Coffee Pesticides with this AI?	Reg 216 Factor E: WHO Acute Toxicity Class	Reg 216 Factor E: EPA Acute Toxicity Classes	Reg 216 Factor E: EPA Chronic Toxicity	Groundwater contaminant. Reg 216 Factors G & H (Non-target ecosystem, Hydrology)	Reg 216 Factors E & G: Ecotoxicity, Non-target Impacts									EPA Registration number
								fish	bees	birds	amphibians	worms	Mollusks	Crustaceans	Aquatic Insects	Plankton	
<i>Beauveria bassiana</i>	microbial	yes	no	NL	III	NL	no data	NAT	NAT	NAT		NAT		NAT			128818
capsaicin/chili extract	botanical	yes	no	NL	III	NL	no data										070701
carbaryl	carbamate	yes	no	II	II, III	PC, ED	potential	MT	HT	PNT	MT	VHT	ST	HT	HT	MT	056801
cyromazine	triazine	yes	no	U	III	ED	potential	MT	ST	MT		MT		MT	NAT		121301
dimethoate	organophosphate	yes	no	II	II	PC, ED, RD	potential	ST	VHT	VHT	HT	MT	VHT	HT	VHT	MT	035001
imidacloprid	neonicotinoid	yes	no	II	II, III	NL	potential	NAT		MT					VHT		129059,
																	129099
insecticidal soap	potassium salts/fatty acids	yes	no	NL	II, III	NL	no data	MT									844600,
																	844606
malathion	organophosphate	yes	no	III	II	PC, ED	potential	MT	HT	MT	HT	ST	VHT	MT	VHT	HT	057701,
mineral oil	petroleum/parafin	yes	no	NL	III	NL	no data	NAT									857701
neem oil	botanical	yes	no	NL	III	NL	no data	ST	NAT	NAT	MT				MT		063503
permethrin	synthetic pyrethroid	yes	no	II	III	PC, ED	no data	VHT	VHT	PNT	ST	ST	ST	VHT	MT	MT	025006
spinetoram	unclassified	yes	no	NL	III	NL	no data	MT		NAT		MT		MT			109701
spinosad	microbial	yes	no	U	III	NL	no data	MT	HT	PNT		ST			HT	MT	110008
spirodiclofen	keto-enol	yes	no	none	II	PC	no data	HT	NAT	MT		MT		HT	HT		110003
spiromesifen	keto-enol	yes	no	NL	III	NL	no data	HT	ST	MT		MT					124871
spirotetramat	keto-enol	yes	no	NL	II, III	NL	no data		MT	MT		MT		MT			024875
thiamethoxam	neonicotinoid	yes	no	NL	III	PC	no data	PNT	HT	PNT		PNT	PNT	PNT	PNT		392201
																	014019

Active Ingredients in Accepted/Recommended Coffee Herbicides

Pesticide Active Ingredients proposed for control of weeds in coffee and thus proposed for Reg 216 analysis	Chemical Class. Reg 216, Factor I Availability of Other Pesticide Options: AI chemical classes for rotation to avoid development of resistance, and reduction of effectiveness (Factor F)	Reg 216, Factor A: Is Pesticide AI EPA Registered?	Reg 216, Factor A: Any Restricted Use Coffee Pesticides with this AI?	Reg 216 Factor E: WHO Acute Toxicity Class	Reg 216 Factor E: EPA Acute Toxicity Classes	Reg 216 Factor E: EPA Chronic Toxicity	Groundwater contaminant. Reg 216 Factors G & H (Non-target ecosystem, Hydrology)	Reg 216 Factors E & G: Ecotoxicity, Non-target Impacts									EPA Registration number
								fish	bees	birds	amphibians	worms	Mollusks	Crustaceans	Aquatic Insects	Plankton	
2 4 D*	chlorophenoxy acid	yes	no	II	III	PC, ED	potential	ST	HT	MT	ST	NAT	NAT	NAT	ST	ST	30001
ametryne	triazine	yes	no	III	III	ED	potential	ST	MT	NAT	MT		MT			ST	080801
clethodim	cyclohexenone	yes	no	NL	II, III	NL	potential	MT	MT	MT		MT		MT			121011
flazasulfuron	sulfonyl urea	yes	no	NL	III	NL	no data	MT	MT	MT		MT		MT	MT		119011
fluazifop-p-butyl	propionic acid	yes	no	III	III	NL	no data	MT	ST	PNT					ST		122809
fomesafen-sodium	diphehyl ether	yes	no	III	II, III	PC	no data	NAT	MT	NAT		MT		NAT		ST	123802
glyphosate	phosphonoglycine	yes	no	U	II, III	NL	potential	ST	ST	NAT		PNT		MT		ST	417300
oryzalin	dinitoaniline	yes	no	U	III	PC, RD	potential	MT	MT	MT		MT		HT		HT	104201
oxyfluorfen	diphehyl ether	yes	no	U	II, III	PC	no data	HT	PNT	PNT			HT		HT	HT	111601
pelargonic/nonanoic acid	natural fatty acid	yes	no	NL	II	NL	no data	HT					HT	HT			031802
sethoxydim	cyclohexadione	yes	no	III	II, III	NL	potential	ST	MT	ST	MT	MT	ST		ST	ST	121001

Active Ingredients in Accepted/Recommended Coffee Nematicides

Pesticide Active Ingredients proposed for control of coffee nematodes and thus proposed for Reg 216 analysis	Chemical Class. Reg 216, Factor I Availability of Other Pesticide Options: AI chemical classes for rotation to avoid development of resistance, and reduction of effectiveness (Factor F)	Reg 216, Factor A: Is Pesticide AI EPA Registered?	Reg 216, Factor A: Any Restricted Use Coffee Pesticides with this AI?	Reg 216 Factor E: WHO Acute Toxicity Class	Reg 216 Factor E: EPA Acute Toxicity Classes	Reg 216 Factor E: EPA Chronic Toxicity	Groundwater contaminant. Reg 216 Factors G & H (Non-target ecosystem, Hydrology)	Reg 216 Factors E & G: Ecotoxicity, Non-target Impacts									US EPA PC Code
								fish	bees	birds	amphibians	worms	Mollusks	Crustaceans	Aquatic Insects	Plankton	
allyl isothiocyanate (mustard oil)	botanical	yes	no	none	III	none	no data	VHT									004901
<i>Bacillus firmus</i>	microbial	yes	no	NL	III	NL	no data	NAT	NAT	NAT		NAT	NAT	NAT	NAT	NAT	029072
capsaicinoids (chili pepper extract)	botanical	yes	no	none	III	none	no data										070701
<i>Myrothecium verrucaria</i>	microbial	yes	no	NL	III	NL	no data										119204
<i>Paecilomyces lilacinus</i> Strain 251	microbial	yes	no	none	III	none	no data										028826
																	003692,
tomatillo oil + thyme oil extracts	soil biopesticide	yes	no		NL	NL	no data										026967

Annex 3: Coffee Rust References

References for Annex 1: IPM Matrix

Anacafe: Sanchez-De Leon, A. 1984. Manual de las enfermedades y plagas del café. Daño y técnicas de control. Guatemala, C. A.: ANACAFE.

FAO coffee EIL references: <http://www.fao.org/docrep/008/ae939e/ae939e0b.htm>

Hawaii Coffee Workshop EILs: <http://www.kohalacenter.org/cbbworkshop/pdf/>

Coffee leaf miners EIL: <http://www.plantwise.org/KnowledgeBank/Datasheet.aspx?dsid=30486>

Ojo de gallo: https://www.anacafe.org/glifos/index.php?title=Prevencion_Ojo_de_Gallo

Cercospora: <http://www.ipmcenters.org/pmsp/pdf/HlcoffeePMSP.pdf>

Source for coffee rust fungicide formulations and dosages:

<http://books.google.com/books?id=Rpc0IgUBOLoC&pg=PA184&lpg=PA184&dq=propiconazole+coffee+rust+kg/ha&source=bl&ots=1357aYkNaX&sig=2KKO2eKjSQCwZiIQc1o0GI7KCA8&hl=en&sa=X&ei=tcWTU-qjH8ybyASwx4KwCQ&ved=0CCQO6AEwAQ#v=onepage&q=propiconazole%20coffee%20rust%20kg%20Fha&f=false>

Coffee Anthracnose IPM and fungicides information:

http://www.extento.hawaii.edu/kbase/crop/type/c_coffe.htm

<http://espace.library.uq.edu.au/view/UQ:295678>

<http://www.bioscipub.com/journals/abi/pdf/249-251.pdf>

<http://www.infonet-biovision.org/default/ct/84/pests>

Coffee Pests, Diseases and their Management:

http://books.google.com/books?id=qm54fhoV1U4C&pg=PA346&lpg=PA346&dq=triadimenol+coffee+rust&source=bl&ots=weLPubsjrp&sig=O4GxEBPwGv_ho7aYZqYfZ1fpNg0&hl=en&sa=X&ei=AqqQU_iRDeGQ0AWhl4FQ&ved=0CEQQ6AEwBA#v=onepage&q=triadimenol%20coffee%20rust&f=false

Coffee Rust: Epidemiology, Resistance and Management

http://books.google.ml/books?id=oK8bKjsgeoC&pg=PA96&lpg=PA96&dq=coffee+rust+sulfur&source=bl&ots=yX04RqyKJh&sig=MGAfVNOA_9_Fji14Uy-cFxWVUY&hl=fr&sa=X&ei=YfKNU6aJN8Ga0AX95oHYBw&ved=0CGsQ6AEwBw#v=onepage&q=coffee%20rust%20sulfur&f=false

German GTZ Plant Protection in Coffee and Curative and Eradicative Effects of Fungicides

http://www.evb.ch/cm_data/4c_pesticide_annex_final.pdf

<http://cdn.intechopen.com/pdfs-wm/12379.pdf>

Annex 4: Environmental Mitigation and Monitoring Plan Example for Coffee Assistance Projects (see Section 4.2, above)

USAID-funded Projects will be required to fill (with recommendations from each PER Section Factor (a-l) analysis in Section 3, above) and use an EMMP compliance tracking and reporting template. This one can be used as a starting point.

Agriculture Inputs: Pesticides Training on, promotion to, purchase of and use by beneficiaries	Pesticide Risks	Mitigation of Pesticide Risks	Pesticides BMP Indicators	Pesticides BMP Responsible Staff Member & Frequency of Monitoring, Reporting	Frequency of Monitoring, Reporting
	<ul style="list-style-type: none"> Integrated Pest Management (IPM) not known or understood or used 	<ul style="list-style-type: none"> Repeated training and use of IPM 	<ul style="list-style-type: none"> IPM tools and tactics understood and used 	<ul style="list-style-type: none"> Project agronomist 	
	<ul style="list-style-type: none"> Pest Management Plans (PMPs) not made 	<ul style="list-style-type: none"> Understand pests of each crop & available pest management tools, and make PMPs 	<ul style="list-style-type: none"> Pest Management Plans (PMPs) present 	<ul style="list-style-type: none"> Project agronomist Project technical staff 	Every two years.
	<ul style="list-style-type: none"> Acute human poisoning leading to death 	<ul style="list-style-type: none"> Training on pesticide risks and use of personal protective equipment (PPE) 	<ul style="list-style-type: none"> All recommended PPE present on demo sites and used 	<ul style="list-style-type: none"> If a pesticide poisoning occurs, immediately inform USAID activity manager Project technical manager 	<ul style="list-style-type: none"> Training every 12 months. Ongoing maintenance of records throughout duration of project.
	<ul style="list-style-type: none"> Chronic human poisoning 	<ul style="list-style-type: none"> Train on and use PPE 	<ul style="list-style-type: none"> PPE used during spraying 	<ul style="list-style-type: none"> Project technical staff Demo farmers 	<ul style="list-style-type: none"> Annual training. Continuous

	leading to future health issues			• Retailers	use of PPE
	• Groundwater (drinking water) & surface water contamination leading to aquatic ecotoxicity (fish kills)	• Training on methods for keeping pesticides out of ground and surface water	• Interviewed farmers understand which pesticides have groundwater pollution potential & how to keep pesticides out of water		
	• Death of pollinator honeybees	• Training on methods for protecting honeybees from spray	• Interviewed farmers understand risks to honeybees		
	• Mass-level local and migratory bird deaths	• Training on pesticide choices & selection	• Interviewed farmers understand pesticide choices & selection criteria		
	• Incorrect pest identification	• Training on identification of most common pests	• Interviewed farmers can positively identify common pests, diseases and weeds		
	• Updated PERSUAP not available	• All pesticide related activities should follow requirements of the PERSUAP	• Updated PERSUAP present		
	• Sprayers leak at every parts junction	• Training on sprayer maintenance	• Sprayers well maintained, not leaking		
	• Use of non-EPA	• Training on banned,	• All pesticide Active Ingredients (AIs)		

	<p>registered pesticides, certain RUP pesticides, Class I pesticides, known carcinogens</p> <ul style="list-style-type: none"> • Incorrect or improper pesticide selection 	<p>prohibited and permitted pesticides</p>	<p>EPA registered</p> <ul style="list-style-type: none"> • No Class I pesticides used • No pesticides containing endosulfan used • Interviewed farmers understand choices & selection criteria 		
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